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THE AUSTRALIAN AND NEW ZEALAND JOURNAL OF SURGERY

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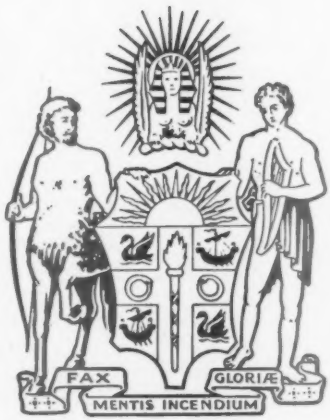

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The Australian and New Zealand
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Vol. 26 — No. 1 AUGUST, 1956

RADICAL SURGERY IN THE PELVIS

By Graham Godfrey

From the Department of Obstetrics and Gynaecology, University of Melbourne, and the Royal Women's Hospital, Melbourne

ALTHOUGH the field of radical pelvic surgery is common to the general surgeon, the urologist, and the gynaecologist, the disease to which the attack is directed necessarily modifies the approach.

This paper deals with extensive pelvic surgery for uterine cancer.

Because carcinoma of the uterus, both cervical and corporeal, often remains localized for a long time, with slow lymphatic spread, and usually metastasizes by the blood stream only in the terminal stages, opportunities are provided for wide excision, whilst its local ravages — pain, bleeding, discharge, and fistula formation — encourage such extensive procedures, even if only for the purpose of palliation.

The surgical attack has developed in a centrifugal manner. To hysterectomy has been added, in successive steps, wide removal of pelvic cellular tissue and of the upper vagina, lymphadenectomy, and, in certain cases, excision of the bladder, the recto-sigmoid, or both.

Pathological Features

The scope and feasability of radical surgery clearly depend upon the assessment of the extent of the disease. This is the first problem.

Evidence gathered from the careful pathological examination of material surgically removed at the Royal Women's Hospital from over 200 cases of carcinoma of the cervix indicates the nature and degree of the difficulty. Infiltrations, particularly those of a non-nodular character, such as commonly occur in the paracervical and utero-sacral regions, are generally inflammatory in nature, and this is true even when the pelvic wall is reached and fixity is produced. In these infiltrations, growth, when present, seldom exceeds a few tumour cells in an odd lymphatic vessel, even though there be a large uterine tumour and lateral lymph node metastases.

Enlarged nodes found at operation are frequently free of growth, and the enlargement is due merely to an inflammatory reaction, whilst tiny nodes which appear harmless may, when microscopically examined, be found to harbour the disease.

Oedema and deformity of the bladder base, due to pelvic cellulitis, are indistinguishable from the appearances produced by growth involving the bladder musculature, and at times the correct diagnosis may be possible only after repeated observations. An illustration will suffice:—

F.S., aged 45, presented with a stump carcinoma of the cervix, which was completely fixed in a "'blocked pelvis." Cystoscopy showed gross bullous oedema and distortion of the bladder base.

It was considered that if surgery were to be performed it would be necessary to remove the bladder. As it was also held that a widespread pelvic cellulitis was present operation was deferred whilst treatment with repeated transfusions, high protein diet, and low dose deep X-ray therapy was carried out.

During the next few weeks the condition of the patient improved and her temperature subsided. Periodic cystoscopic examinations showed steady improvement in the condition of the bladder, and

some mobility developed in the cervix. Finally, eighteen weeks after beginning treatment, radical hysterectomy with lymphadenectomy was performed without undue difficulty or post-operative complication.

The pathologist, Dr. H. F. Bettinger, reported that there was no evidence of growth outside the cervix, and the prognosis became that of Stage I carcinoma of the cervix.

Our experience therefore leads us to believe:—

1. In nearly all cases of apparently extensive intrapelvic growth, especially when tenderness or a raised temperature are noted, the probability of an inflammatory element should be considered.

FIG. I. Operative specimen of typical radical hysterectomy showing wide removal of paracervical and paravaginal cellular tissues Material removed by lymphadenectomy not shown.

Treatment by antibiotics, transfusion, diet, and low dosage deep X-ray therapy frequently alters the picture. The time thus occupied, even should it amount to several weeks, is time well spent. It is the recognition of the inflammatory factor which mainly has been responsible for the rise in the operability rate for carcinoma of the cervix at the Royal Women's Hospital from 35-40 per cent. in 1950-51 to 65-70 per cent. in 1954-55.

2. Lymphadenectomy should be performed systematically and thoroughly, aiming at the widest possible clearance of the lymphatic fields in every case. There is no point in removing only visible or palpable nodes. This is simply biopsy.

3. Enlarged nodes outside the planned field of clearance may not contain growth. It is often worthwhile obtaining a frozen section under such circumstances. In this connection, too, it might be pointed out that, when the intent of the operation is palliative, the existence of metastases does not necessarily contra-indicate operation.

FIG. II. Dissection of right obturator fossa. From above down can be seen the genito-femoral nerve lying on the psoas muscle, the external iliac artery, the external iliac vein, the obturator nerve crossing the fossa, the lower part of the right ureter, and a small part of the internal iliac artery.

SURGICAL CONSIDERATIONS

The basic operation for uterine cancer which does not involve bladder or bowel is the modern extended radical hysterectomy, which includes removal of one-half to three-quarters of the vagina and wide excision of the paracervical and paravaginal cellular tissues (Fig. I), plus a lymphadenectomy embracing the common, external and internal iliac, the obturator, and the pararectal nodes (Fig. II). Recently we have, in the Royal Women's Hospital, also cleared the nodes and tissue of the post-rectal area as a routine (Fig. III). For those hitherto inoperable and virtually untreatable cases, in which bladder or bowel have been invaded, the exenterations — anterior, posterior, and total —have been devised by Brunschwig, who has added to the basic procedure more extensive or total removal of the vagina, together

with cystectomy and/or recto-sigmoidectomy. These operations are carried out either by the abdominal or the abdomino-perineal approach as circumstances demand.

It must be empasized that from the point of view of cancer surgery the clearance of cellular and node-bearing tissue is fundamental. This involves complete stripping of the perivascular tissues from the great vessels on the lateral pelvic walls and clearing of the lumbosacral plexus.

Preparation of the patient for surgery

The preparation of the patient for radical surgery may be likened to military logistics, that is to say, the battle is usually won or lost before the patient goes to the theatre. Without taking up time with a comprehensive consideration of details it may be stated that examination under anaesthesia, cystoscopy, proctoscopy, intravenous pyelography and chest radiography, together with blood and electrolyte estimations and bacteriological studies are done as a routine. High protein, high vitamin diet, blood transfusion when indicated, bowel preparation, including administration of antibiotics, and antiseptic vaginal douching precede the operation. One week is the minimal time for preparation, and there should be no hesitation to entend this if the condition of the patient is not satisfactory.

Anaesthesia and resuscitation

The surgeon can to some extent modify the magnitude of this problem by gentleness and step by step control of haemorrhage, and by avoiding attempts at operating with speed. Apart from this the problem has to be faced by the anaesthetist. I am indebted to Dr. K. McCaul, Director of Anaesthesia at the Royal Women's Hospital, for the following summary of his views. "Without operation these patients face a bleak future, and as they are always extremely anxious for surgical relief we are not unduly rigid in our assessment of anaesthetic risk.

Most curent anaesthetic techniques have been used and, apart from their failure to give control over bleeding, they have produced good operating conditions. In an effort to reduce haemorrhage the technique of continuous epidural analgesia with light general anaesthetic cover was tried and has now been in routine use during the past three years. Epidural analgesia provides considerable control over arterial bleeding though it has little or no effect on venous ooze. It offers the surgeon almost identical operating conditions to those experienced a decade or two ago when high spinal analgesia was popular. The main advantages over standard spinal techniques are that there is no risk of meningitis or post-spinal headache and, most important, further anaesthetic solution can be injected through a nylon catheter at intervals. Consequently no time limit is imposed on the surgeon.

The patients are anaesthetised with a small dose of Thiopentone, the trachea is sprayed with a local anaesthetic solution, and endotracheal nitrous oxide and oxygen is administered. No relaxants or other anaesthetic agents are required. The systolic blood pressure usually settles at 50 mm. of mercury; if it drops lower than this the legs are raised and the patient transfused if necessary. It appears well to slightly over-transfuse, and we now endeavour to keep a pint ahead of the estimated blood loss. The average volume of transfusion during operation using this anaesthetic technique is three pints as against an average of seven to eight pints with the other types of anaesthesia used.

Post-operatively it is worth while to keep in mind the enormous raw area which results from this surgery and has a very considerable capacity to exude serum. Sudden, even dramatic, falls in blood pressure during the immediate post-operative period are almost certain to be due to serous loss.

The morale factor in these patients needs some consideration, and as they are often destined to have a series of anaesthetics for various reasons, it is felt that it is wise from the outset to avoid any form of anaesthesia which is unpleasant to them during induction or following operation."

The incision

The transverse muscle-cutting incision has proved to be of considerable value in this type of surgery. This incision lends itself

perfectly to the use of a light frame of stainless steel wire to which the edges of the peritoneum are attached by rubber straps and clips (Figs. IV and V).

FIG. III. The dissection shows from left to right the right common, internal, and external iliac vessels, the sacral promontory, and the left internal and external iliac veins joining to form a very short common iliac vessel. Below the sacral promontory the upper part of the post-rectal clearance is visible. This dissection is carried down to the coccyx. If the incision in the posterior parietal peritoneum is carried well upwards, after division of the right infundibulopelvic fold, the recto-sigmoid and the right ureter can be displaced without tension to the left pelvic brim, and the dissection as illustrated performed without difficulty. The desirability of clearing the post-rectal nodebearing tissue was suggested by several cases of recurrence in this area.

The advantages of this incision are:—

1. Wide exposure and easy access to the lateral pelvic walls.

2. Comfort in operating, since there is plenty of space for manoeuvre.

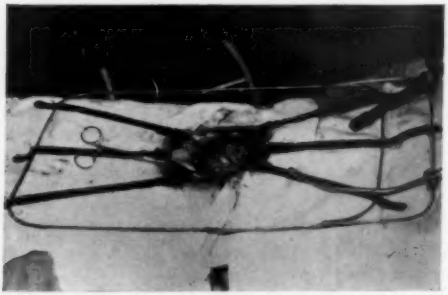

FIG. IV. Shows use of light frame of stainless steel with three studs at each end. Rubber straps perforated at intervals carry steel clips which are attached to the edges of the peritoneum. The straps are fastened to the frame by inserting the studs into appropriate perforations.

3. Less post-operative pain, due doubtless to absence of muscle damage from fixed retraction, and the fact that the incision is confined to the lowest portion of the abdomen.

4. The avoidance of handling small bowel, which is slipped up above the sacral promontory and retained by a rolled scarf. This may be at least partly responsible for the almost complete absence of paralytic ileus in our series.

The incidence of incisional hernia is about the same as with vertical incisions and occurs in a similar type of patient and under similar conditions. There is undoubtedly an increased tendency to haematoma formation. For this reason the subaponeurotic area should be drained for twenty-four to forty-eight hours, and this has proved effective.

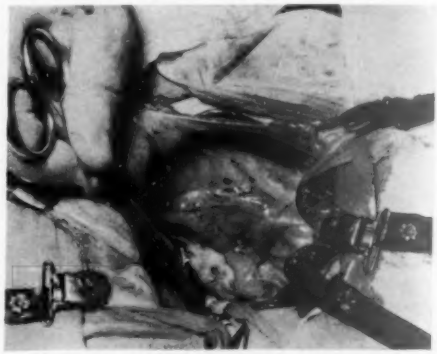

FIG. V. Closer view of transverse incision with frame in use to show exposure and easy access to lateral pelvic walls.

Mobilization of the pelvic contents

A variable amount of fixity of the pelvic contents is commonly encountered, due more often to the residuum of infection, or radiotherapy than to growth. The site at which the main obstacles are met is the lateral pelvic wall. If, after division of the infundibulopelvic folds, the dissection be commenced lateral to the aortic bifurcation and carried down along the common and external iliac vessels, and thence down the internal iliacs and into the obturator fossa, the most difficult region is explored first, before the surgeon is committed to an extensive operation, and control over the large vessels is obtained at an early stage. It is usually possible also to

detach the lateral ligaments sufficiently from the pelvic wall to obtain some degree of mobility. Once it is certain that pelvic clearance can be accomplished it may pay to move to an easier plane and, by a shifting attack, to develop the operation. In difficult cases it may be necessary to carry out part of the procedure by touch alone, clamping and cutting without direct vision. This is a most unpleasant experience in anterior exenterations where damage to the rectum must be avoided.

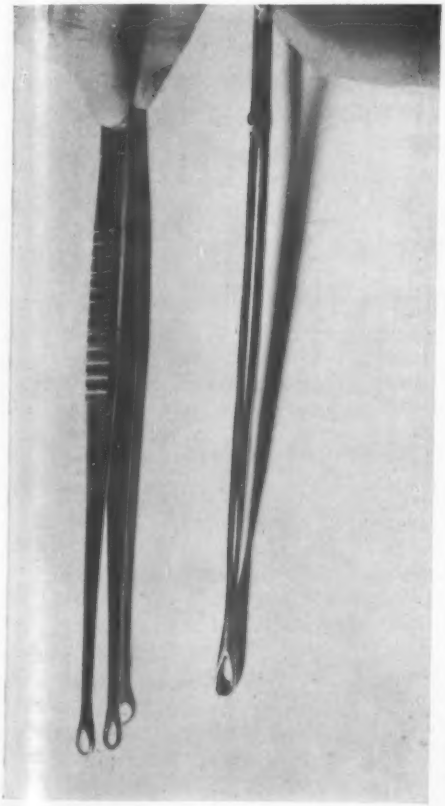

FIG. VI. Fine sponge holding forceps for clamping veins (on the right) and Meigs' gland dissecting forceps (on the left).

Venous haemorrhage

Despite all care large veins are occasionally torn and a severe haemorrhage results. A quick finger may control the rent, but sometimes the technique applicable to the torn renal vein must be used — a pack and temporary inactivity.

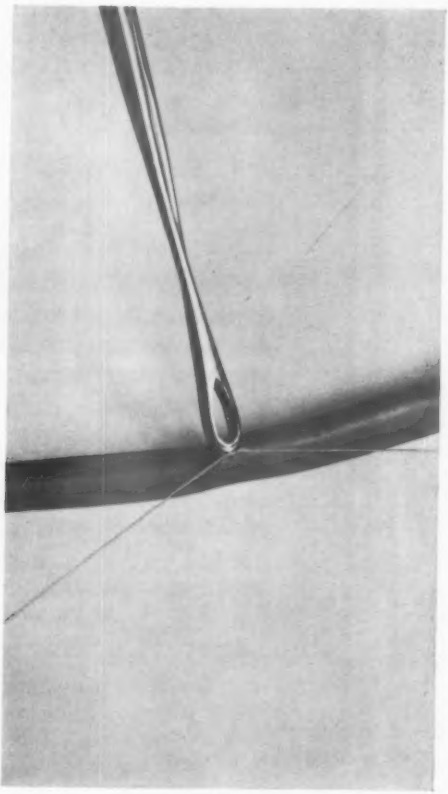

FIG. VII. Fine sponge holding forceps applied to rubber tubing. Half-completed ligature to illustrate manner in which lateral tie may be applied.

The most suitable instrument for clamping these vessels is a very fine pair of sponge-holding forceps (Fig. VI). This, because of its shape, allows the application of a free ligature, which as it is tightened slides down on to the vessel (Fig. VII). Artery forceps and similar instruments tend to cause further tearing, usually preclude the use of a free tie, and lead to sutures carried on needles, the points of which have an uncanny knack of wounding other vessels. Fine sponge-holding forceps are well adapted also for placing lateral ties on large vessels when smaller tributaries are avulsed.

Haemorrhage from small veins is usually controlled by diathermy, but this is not true in the case of the gluteal and lateral sacral vessels, which invariably retract. When this happens it is best to pack these areas for the time being and to proceed to another part of the dissection.

Anterior exenteration:

In contrast to total exenterations, anterior and posterior exenterations carry a lesser immediate risk, produce a relatively better way of living, and, because they are performed for less extensive disease, have a greater chance of producing long-term survival Posterior exenterations are not often indicated in the treatment of gynaecological cancer. For these reasons most of our material consists of anterior exenterations. The results to date are indicated in the chart (Fig. VIII).

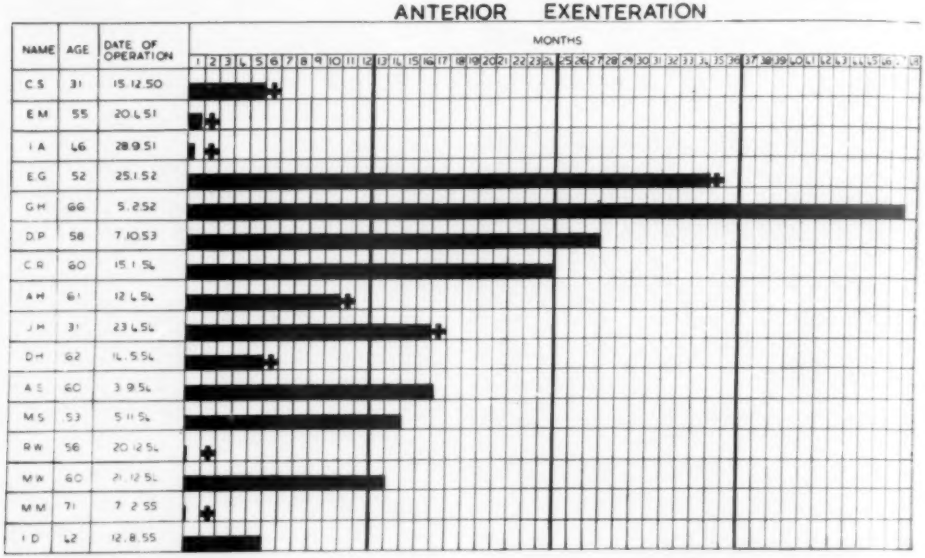

FIG. VIII. Chart showing results of anterior exenterations.

The exenterations

The various types of exenteration are:

1. Partial pelvic exenteration:
   (a) Anterior — with removal of bladder and uretero-colic anastomosis.
   (b) Posterior — with removal of recto-sigmoid colon and terminal colostomy.
2. Complete pelvic exenteration:
   With removal of bladder and recto-sigmoid colon.

   Two methods:
   (a) with uretero-colic anastomosis above an end colostomy;
   (b) with ureteric implantation into a "substitute" bladder, and a separate end colostomy.

As can be seen, the primary mortality is formidable, and the number of long-term survivors is small. It must be remembered, however, that these patients were not merely doomed, but were already in an insupportable condition. A high immediate mortality rate must be faced, due as much to the condition of the subjects as to the rigours of the operation, but it is probable that as in other comparable surgical fields increased experience will to some extent lower this figure.

A more rigid selection of cases clearly would reduce the initial loss, but it is difficult to refuse a chance of relief to patients who

know the risks, and who urge that they be taken. Survival figures of course do not show the most important aspect of this type of treatment — namely, palliation.

In general it may be said that a reasonable way of life is achieved, that patients can return to their own homes, often to lead quite an active existence, and that those who die of the disease later at least do so in dry beds.

The worst disaster following anterior exenteration is the development of a recto-vaginal fistula. This has occurred three times in our series, twice in the terminal stages because of growth recurrence, and once because of radionecrosis.

Posterior exenteration:

Uterine growths which involve the rectum are usually of such extent that if they are to

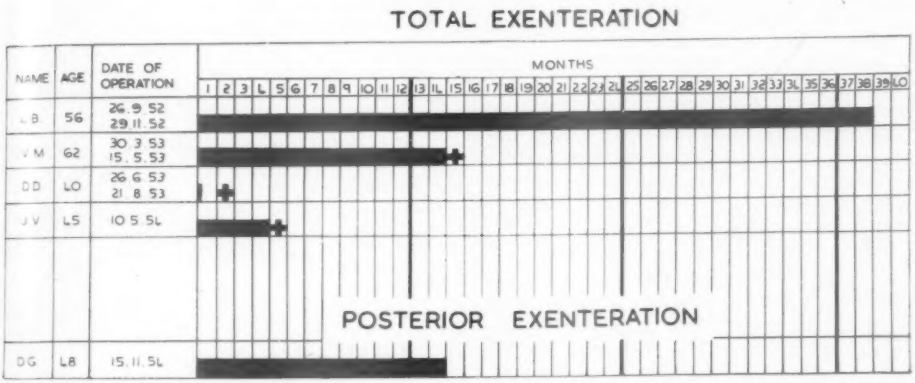

FIG. IX. Chart showing results of total exenterations and posterior exenteration.

In anterior exenteration it is our practice to divert the urinary flow by uretero-sigmoid anastomosis. This is a comparatively minor addition to the major operation. More complicated procedures for dealing with the loss of the bladder add to the hazards and seem to us to be more suitable to staged operations.

Providing the kidneys are not infected or damaged prior to operation there has been in our experience only moderate risk of subsequent pyelonephritis. Some degree of hydronephrosis is common, but this is usually non-progressive and renal function remains satisfactory. The clinical material on which this opinion is based includes, in addition to exenterations, uretero-sigmoid anastomoses performed for radionecrotic or post-operative urinary fistulae or solely for palliation.

Although post-operative electrolyte studies indicate the regular development of a mild hyperchloraemic acidosis, some form of adaptation seems to occur, and the "reabsorption" syndrome has seldom amounted to a clinical problem.

be attacked surgically, total exenteration is required. The main indication for posterior exenteration in gynaecology is the occurrence of primary carcinoma arising in the posterior wall of the vagina. We have one such patient. She has passed the first anniversary of her operation in good health, with no clinical evidence of residual disease (Fig. IX). There is also scope for this operation in the treatment of certain cases of carcinoma of the rectum.

Because of lack of experience no further comment will be made beyond pointing out that the life led subsequently is the well-known colostomy life, and that the most unpleasant complication would be the development of a urinary fistula.

Total exenteration:

Our experience of this operation is summarized in Fig. IX.

Technically this is the least difficult of the exenterations, because dissection is carried out in the easy pre-vesical and post-rectal

rather than in the difficult vesico-vaginal and recto-vaginal planes.

The method for dealing with the urinary flow presents the problem. The choice lies between implantation of the ureters into the sigmoid colon proximal to an end colostomy —the so-called "wet" colostomy — and the formation of a substitute bladder.

"Wet" Colostomy:

Uretero-sigmoid anastomosis above an end colostomy has the great advantage that it is a minor addition to the exenteration and, consequently, that only one operation is needed. The disadvantage is that a collecting apparatus must be worn. In the only case in which we chose this method the patient was unable to manage the bag satisfactorily. Such information as can be gathered suggests that this is not unusual.

Substitute bladder operations:

Bricker has described the operation of implanting the ureters into an isolated loop of ileum, one end of which is closed, the other being brought out on the abdominal wall. As with the "wet" colostomy a collecting apparatus must be worn. The procedure, though less complicated than the Gilchrist operation, is far more than a minor addition to exenteration. Perhaps it might more properly constitute the first part of a staged operation. The chief advantage claimed is that the chance of renal infection is greatly reduced in comparison with uretero-sigmoid anastomosis in continuity. We have no experience with this procedure.

The method of urinary diversion which we have used on three occasions with total exenterations, as well as in the palliative treatment of patients with combined urinary and faecal fistulae, has been that described by Gilchrist *et alii*, in which the substitute bladder is formed from the isolated right colon and terminal ileum.

This gives the most satisfactory end result, but it is a time-consuming procedure and we combine it with exenteration in a two-stage operation. The first stage consists in construction of the substitute bladder, the ureters being transplanted into it at the second operation, after exenteration has been carried out and an end colostomy has been formed.

The interval between the two operations, usually several weeks, allows the isolated colonic segment to become fixed in the position to which it has been transposed, and provides an opportunity to reduce the bacterial content through mechanical cleansing by washouts and by the instillation of antibiotic suspensions. The advantage of this needs no stressing.

The capacity of a substitute bladder constructed in this way is approximately 12 ounces; the ileocaecal valve is competent as long as overfilling does not occur. The patient passes a catheter at such intervals as her experience dictates. This is usually about every three hours. No collecting apparatus is required and continence is achieved.

The substitute bladder is easily examined by the cystoscope, and urine can be collected for bacteriological study and for the performance of renal function tests. It is probable too that the chance of renal infection is less than with a "wet" colostomy.

One of the practical difficulties is caused by secretion of mucus by the colon. This is usually copious, and is not only an embarrassment at the time of operation but may, by blocking catheters, interfere subsequently with proper emptying of the substitute bladder.

The secretion has been greatly reduced by a technique developed by Dr. W. P. Holman, Honorary Radiotherapist to the Royal Women's Hospital. After localization, by means of a barium meal, he irradiates the right colon pre-operatively with a dose of 1500 r. delivered over a three weeks' period. The diminution of mucus secretion is striking.

In summary, the lesser immediate risks and ordeal for the patient of exenteration with "wet" colostomy must be balanced against the much better way of living and, perhaps, the improved long-term prospects when exenteration is combined with the Gilchrist operation.

It is our practice to discuss this with the patient, and it is significant that those given the choice have elected to face two operations in order to gain the obvious advantages if success is attained.

SELECTION OF CASES FOR EXENTERATION

The type of surgery employed when bladder or bowel is involved is essentially palliative and long-term survival is in the nature of an occasional bonus. Judged by this standard the worth of successful operations is undoubted.

Since these patients have so little to lose the very high primary mortality may be accepted, but the risk that they may be submitted to one or more extensive operations without any benefit, or even a worsening of their condition, makes it imperative that only those who have a reasonable chance of amelioration be subjected to surgery, and that technical feasibility be not the sole yardstick. Futile operations will serve only to discredit procedures which, used with discretion, can be of the greatest value to those charged with the management of advanced cancer.

Holding these views we restrict these operations to patients in distress, except in the occasional instance where it is felt that a reasonable chance of long-term survival exists—for example, a growth of the anterior lip of the cervix which has invaded the bladder locally, the remainder of the pelvis being clinically clear, or a primary carcinoma of the posterior vaginal wall which has involved the rectum. Apart from such cases we use the simplest procedure which will alleviate the symptoms, such as colostomy, uretero-sigmoid anastomosis, or even a Gilchrist operation, without attacking the growth. Exenterations are reserved for those cases where the lesser operations have little or nothing to offer.

Clearly patients must be made aware of the risks, the complications, the possible failure to relieve, and the type of life which they will lead if the operation succeeds in its aims. Adaptation to a way of life which, whilst it may be infinitely preferable to existing conditions, must contrast unfavourably with the normal state of affairs, requires of the patient a high morale and at least reasonable intelligence. These factors need very careful assessment.

As far as the surgeon is concerned a knowledge of the disease, and of how those suffering from it live, and how they die, outweighs technical considerations.

It will be agreed that it is difficult to define an attitude towards this type of surgery. Our view is that if the patient understands the situation, and if there is a reasonable chance of obtaining palliation, operation is offered. Under no circumstances is it urged.

The aim is to offer help to those whose outlook has been simply expressed in the words of a patient — "Doctor, I know what is wrong with me and that I have not long to live. I am prepared to go out. I am not prepared to go on."

SUMMARY

1. Certain pathological features of uterine cancer are considered.
2. The following aspects of radical surgery in the pelvis are discussed:
   (i) Preparation of the patient.
   (ii) Anaesthesia and resuscitation.
   (iii) The incision.
   (iv) The operation.
      (a) Mobilization of pelvic contents.
      (b) Control of venous haemorrhage.
3. The results of the anterior, posterior, and total exenteration operations performed in the Radio-Surgical Clinic at the Royal Women's Hospital are presented.
4. Methods of dealing with the ureters following cystectomy are discussed.
5. Criteria used in the selection of patients for exenteration operations are outlined.

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DIABETIC GANGRENE

SOME OBSERVATIONS ON ITS PATHOLOGY AND TREATMENT

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THE appearance of an infective or ischaemic lesion in a toe is a sufficiently ominous event in the life of a diabetic. Involvement of the foot proper greatly magnifies the problem, in that amputation of a limb rather than a digit may now be necessary, and an actual threat to life may rapidly develop. Of recent years, more effective control of both diabetic acidosis and infection has considerably reduced the mortality of diabetic gangrene, but the problem of the level of amputation remains. It has generally been taught that spread beyond the toes is almost always an indication for amputation of the limb, often above the knee. Hopes for a less radical amputation in these cases have been sustained by the knowledge that in diabetic gangrene, as opposed to senile or arteriosclerotic gangrene, ischaemia is only partly responsible for the death of tissue. If infection, the additional factor, can be controlled, the surviving tissues will often possess sufficient circulation to justify a more conservative amputation, especially as the arterial block is often peripheral in the diabetic (Rob, 1954). However, because some ischaemia is nearly always present, it is virtually never possible to employ the classical amputations of Syme, Chopart or Lisfranc. Simple removal of necrotic soft tissue is equally unsatisfactory, because it exposes part of a metatarsal bone, which prevents healing.

To overcome this problem, operations involving metatarsal resection have been devised, one of the earliest and most important being the trans-metatarsal amputation of McKittrick (1949). In this operation, the forefoot is amputated through the necks of all the metatarsal bones, the wound being closed with a long plantar flap, which is sutured to the dorsal skin without drainage. Unfortunately, many cases are unsuitable for this operation. In some, infection makes closure of the wound unsafe. In others, a perforating ulcer, or infection in the plantar fascia precludes the fashioning of a plantar flap. When the latter can be used, kinking at the base may endanger its blood supply, and great care must be exercised to avoid cutting a flap which is either too long for its blood supply, or too short to permit suture without tension.

As an alternative, and largely by trial and error, operations have evolved, which, though less classical in conception, secure satisfactory healing and function in a good proportion of cases. This is achieved by removing only those tissues which are found at operation to be necrotic, and those, such as bare bone and tendon, which will prevent healing if not removed. All useful viable tissue is preserved, the emphasis being on function, and not appearance. Although this method has been used in some centres for several years (Perkins, quoted by Norman, 1955), its possibilities and advantages are not widely known, and it is not yet established in orthodox surgical teaching. Admittedly, it can only be applied to a small group of cases, and of these, some will fail. Nevertheless, it is felt that sufficient feet can be saved from an otherwise inevitable amputation to justify a close study of the method. It is based on an appreciation of the pathology of the various ischaemic and infective lesions seen in feet of diabetic patients, and these will be described in some detail before clinical management, and some illustrative cases, are considered.

Pathology

(i) *Soft tissue gangrene*

Gangrene of the foot is common in the elderly, and in some diabetics it may be

purely ischaemic in origin. These patients are, in effect, suffering from senile or arteriosclerotic gangrene, and have the same prognosis. The ischaemia is likely to be widespread in the foot, and the opportunities for successful metatarsal resection will be very limited.

In a second group, gangrene is due to a combination of arteriosclerosis and infection, and the greater the contribution of the latter, the more hopefully can one anticipate a useful circulation in the tissues which survive.

There is a third group, composed mainly of younger patients, in whom the circulation is good, and the gangrene is due almost entirely to the diabetic's unfortunate susceptibility to infection. The organism is likely to be virulent, and the death of tissue is due either to the direct action of toxins on the cells, or to septic thrombosis in the arteries supplying the part. The latter process is frequently demonstrable at operation. Provided that the infection can be controlled, these are the cases most likely to benefit from metatarsal resection. They also constitute the most urgent indication for operation, as fulminating infective gangrene may urgently threaten both limb and life.

Fig. I

Fig. II

FIGS. I and II. "Infected corn" of fifth toe complicated by septic arthritis.

(ii) *Spread of infection*

The paths of spread of infection must be clearly understood if spread is to be anticipated before it occurs, and adequately drained when present. At times it may be violent and rapid. More often it is not, and follows paths so subtle and deep as to remain undetected until it is firmly established in the tendons and their sheaths, the small joints of the foot, or the ramifications of the plantar fascia. The elderly diabetic may be but dimly aware of what is happening in the numb soles of his feet, and the inflammatory reaction is often feeble. A common, and more serious hazard is the suppression of superficial evidence of deep infection by the action of antibiotics.

Spread of infection from a toe into the foot commonly follows tendons, and is more likely to escape detection when it involves the more deeply placed flexor tendons. A serious, yet common error, is to treat diabetic gangrene as senile gangrene, and wait for separation to occur. During the period of waiting, organisms multiply and spread beneath the black surface crust.

(iii) *The perforating ulcer*

This lesion, if neglected, may be the first of a train of events leading to an irretrievable situation. Treatment of the perforating ulcer is given little space in standard textbooks of surgery, partly because of the ineffectiveness of orthodox methods of treatment, and partly because these ulcers and their evil consequences often develop slowly, and may appear to heal from time to time. Inevitably the tendons in relation to the ulcer become infected, and open up an avenue of spread. Septic arthritis of the interphalangeal and metatarso-phalangeal joints is common, and will never heal (Figs. I and II). Abscess of the plantar fascia is often the result of direct spread of infection from a perforating ulcer. Finally, thrombosis of the digital vessels in relation to the ulcer, and gangrene of the corresponding toe, is by no means uncommon. Perforating ulcers are often found in relation to patches of anaesthesia, a circumstance which is known to carry a poor prognosis. It has been found, however, that this by no means precludes a successful metatarsal resection.

(iv) *Infection of the plantar fascia*

This may be the first evidence of infection in the foot, and behaves like a carbuncle. More often it is the result of direct spread from an infected toe, an infected callus, or a perforating ulcer, and is a serious complication. The ramifications of this fascia, especially its deep processes, promote the spread of infection, and militate against successful drainage by simple incision. Plantar fascia exposed in a wound quickly sloughs, and infection will spread in it deep to the margins of a well-drained wound. It can only be eliminated by painstaking dissection.

TREATMENT

(i) *The diabetes*

In the present series the gangrene has been the result of infection, ischaemia and neuropathy in varying degrees and combination. The commonest age incidence has been in the sixth and seventh decades. There have been no characteristic features of the diabetic state itself apart from the commonly observed rise in insulin requirements in the presence of infection, and a fall after its eradication. The duration of diabetes prior to the development of gangrene has varied considerably, being shorter, in general, in the older patients.

Control of the diabetes as rapidly as possible has been achieved by administration of regular insulin at frequent intervals as a supplement to the established insulin regime, using blood and urine sugar levels as a guide to dosage.

Surgical intervention has been given precedence over the control of diabetes when there has been an abscess, since immaculate control will not prevent extension of an established infection. However, for elective procedures, such as amputation of toes, or metatarsal resection, preliminary control of blood and urine sugar levels has been regarded as essential.

The operation is brief, and skilfully given light anaesthesia has not interfered with patients' ability to take early post-operative feedings. There has been no difficulty in the control of the diabetes after operation. Dosage is so arranged that the operation takes place during a phase of waning insulin activity, thus avoiding the risk of hypoglycaemia. Supplementary doses of regular insulin are used post-operatively to cover any deficit invoked by pre-operative insulin alterations, or the surgical procedure itself.

(ii) *Preliminary assessment of the case*

A careful history, and detailed clinical examination of the lesion and the circulation in the limb usually permit a fairly accurate estimate of the relative contributions of infection and ischaemia to the gangrene. It is not always easy to predict the result of operation. Extensive dry gangrene, especially on the dorsum of the foot, usually indicates that any attempt at local amputation will be futile, but unless the indications are unequivocal, a conservative approach is first made. Good healing may be achieved in spite of absence of palpable pulses at the knee and ankle.

(iii) *X-ray examination*

This is always done to detect the extent of bone and joint involvement.

(iv) *Chemotherapy*

Chemotherapy according to culture is always given. It helps to localize infection, and to control spread of infection at and after the time of operation. It must be emphasized that once bone, joint, tendon or plantar fascia is involved, chemotherapy cannot produce resolution, and will often suppress clinical evidence of deep spread. It is dangerous to defer surgery because chemotherapy appears to have cured a deep infection.

(v) *Operative treatment*

(a) *Preliminary drainage.* A decision on drainage must be made as soon as infective gangrene has been diagnosed. Immediate drainage is not always necessary. There may be early superficial infective gangrene spreading slowly from the edge of a toenail, or mild infection in a perforating ulcer. Occasionally, nibbling away part of a hard crust on a toe, or unroofing of an infected callus will provide adequate drainage. Once spread into the foot has occurred, however, more radical measures are necessary, often involving open amputation of a toe, and a bold incision into the foot. Such an incision will do far less damage to the circulation than failure to drain a pocket of pus, or to remove a necrotic tendon. An operation which starts as a simple ampuation of a toe will often reveal a surprising collection of pus and dead tissue in the foot. A track will be found, usually along a flexor tendon, connecting a gangrenous toe and a plantar abscess, or a perforating ulcer. This track must be widely laid open by a plantar incision which forms the long handle of a raquet amputation of the dead toe. The exposed tendons are pulled down and divided beyond the area of slough, and obvious dead tissue, such as sloughing plantar fascia, is excised. The wound is left widely open, and will usually require revision two or three weeks later, when a definitive metatarsal resection can be performed.

(b) *Amputation of a toe.* Prompt amputation of a toe will often prevent spread to the foot. Satisfactory results have been obtained from a guillotine amputation through viable skin, followed by filleting out the exposed phalanx with narrow-bladed bone nibblers for about one centimetre. The tendons are then dissected back through the cavity so formed, taking care not to damage the digital vessels. A cylinder of viable soft tissue remains, having good drainage and no exposed tendon or bone. The edges are allowed to fall together without suture, and uneventful healing is the rule.

(c) *Metatarsal resection.* This is considered whenever gangrene has spread from a toe on to the foot, where there is a perforating ulcer and septic arthritis of a metatarsal joint, and in all cases in which radical drainage has left bone exposed.

The operation may be performed in one or several stages, depending on the extent of infection. Cases in which infection is mild can be subjected to a one-stage operation with confidence. When, on the other hand, there is substantial spread of infection into the foot, the initial amputation simply removes most of the dead tissue and provides free drainage. Subsequent revision operations, and possibly skin grafting will be necessary to secure healing.

Great individual variation is seen from case to case; nevertheless, the following general rules of procedure are applicable to all:

(i) All operations are performed under general anaesthesia.

(ii) No tourniquet is used.

(iii) No strong antiseptics are used.

(iv) All dead and chronically infected tissues are removed. This includes excision of infected joints. An incision on to the foot is necessary, and is usually best placed on the sole. This incision gives good access to the flexor tendons and plantar fascia, and will include any perforating ulcer. The blood supply is better on the sole than on the dorsum of the foot, where gangrene carries a much poorer prognosis, and furthermore, a plantar incision gives the most satisfactory drainage.

(v) All potentially useful living soft tissues are carefully preserved by gentle handling and avoidance of unnecessary retraction, and care must be taken not to damage intact blood vessels. To achieve this, bone is resected sub-periosteally, and soft tissues are removed by accurate sharp dissection.

(vi) Living tissues which have a poor blood supply and which would almost certainly undergo necrosis from exposure are next removed.

(a) Tendons are pulled down and divided through living tendon at a point which will retract well away from the surface of the wound.

(b) Exposed plantar fascia is dissected away as completely as possible. This is often tedious and difficult, but must be complete if healing is to be secured.

(c) Joint capsules, sesamoid bones and ligaments must all be removed if they are visible in the wound. Their dissection may endanger the blood supply of a neighbouring toe, but if lateral spread of infection makes this necessary, there should be no hesitation in amputating this toe, and filleting out the head and neck of the corresponding metatarsal bone.

(d) Exposed bone is removed subperiosteally until it is no longer visible in the wound, and until the soft tissues fall naturally together. It is often rarefied and soft, and is readily removed with long, narrow-bladed nibblers without damage to the surrounding soft tissues and vessels. Usually the head and one-half to two-thirds of one or more metatarsal bones must be resected. It is important not to expose an uninfected tarso-metatarsal joint to infection, for once the small tarsal joints become involved there is little hope of saving the foot.

(vii) *Haemostasis*

Ligation of vessels is rarely necessary, and fine catgut is used sparingly. Pressure with fine forceps is usually adequate.

The aim of the operation is to obtain a wound lined by living soft tissues, with the edges falling easily together. Because of the risks of sepsis and tension, no sutures are used. The wound is lightly dressed with one layer of *tulle gras* and several layers of gauze, and the whole foot and ankle are padded with wool and gently bandaged to protect all pressure points.

Lumbar sympathectomy has been used in several cases in which it appeared likely that a useful increase in cutaneous circulation would be obtained. The numbers are insufficient to permit any definite conclusions as to its value, and many factors, such as age, diabetic acidosis, active infection, and cardiac insufficiency have prevented its more general application. This operation is performed if, in the surgeon's judgment, the risk of operation is small enough to be justified by the prospect of converting a doubtful promise of healing into a reasonable hope. Vaso-dilator drugs have not been used as a routine.

POST-OPERATIVE MANAGEMENT

The after-care and rehabilitation of the limb are quite as important as the operation itself, and require detailed supervision by the surgeon. The foot is nursed on one soft pillow to avoid the ischaemia of elevation, and the congestion of dependence. The wound is inspected within twenty-four hours to ensure that there is no pressure from dressings, or impairment of drainage, and is then re-dressed only as often as soiling demands. Persistent purulent drainage and the discovery of sloughs indicate the need for revision of the wound, and if this cannot be achieved by simple trimming of sloughs in the ward, formal revision in the theatre is indicated

Vaseline is used sparingly and only to prevent painful adhesion of dressings to the wound: dry dressings are preferred. Small areas of dead tissue may require wet dressings with a dilute solution of Eusol. Healing is usually slow, and the application of pinch grafts to granulating areas will often accelerate closure.

Fig. III

Fig. IV

FIGS. III and IV. Result of resection of second metatarsal bone and second toe (Case 3).

Return to weight-bearing must be very cautious. For at least three weeks the patient should practice hanging exercises, to accustom the circulation to the vertical position. He must also learn to bandage the foot, which will be prone to cyanosis and oedema. A period of limited weight-bearing follows, using crutches, until he can finally walk unaided, or with a stick. Progress through these stages is governed by the condition of the foot, and the patient must fully understand its care, and the early signs of danger. He is encouraged to wear his usual shoes, padded where necessary with wool, and it is often surprising how well the foot will function. The patient is naturally delighted to be walking at all, and may have to be restrained from attempting more rapid progress than the foot will stand.

CASE HISTORIES

The following case histories have been selected to illustrate some of the problems which may confront the surgeon. Three failures are included, to emphasize errors which can be eliminated by a proper understanding of the pathology of diabetic complications, increasing experience, and a more aggressive approach to their surgical treatment.

Case 1

Mr. S., an amputee, 67 years of age, developed gangrene of his surviving great toe. There was a perforating ulcer under the head of the first metatarsal bone, and infection was not a prominent feature. The gangrene involved all the great toe, the first web space extending on to the second toe, and the ball of the foot. No pulses could be felt distal to the femoral pulse, and definite, though not marked, postural colour changes were present.

At operation, all dead tissue, the first and second toes, and about two-thirds of the corresponding metatarsals were resected. The wound edges were allowed to fall together without tension. No vessels bled enough to require ligation. Slow but steady healing took place in twenty-eight days, and after a period of hanging exercises, Mr. S. was able to walk again with the help of his prosthesis on the amputated limb. This he did for eighteen months, when he died of a stroke (Figs. V and VI).

Fig. V

Fig. VI

FIGS. V. and VI. Perforating ulcer of sole complicated by gangrene of the great toe. Successful metatarsal resection (Case 1).

Case 2

Mrs. S., a stout, poorly controlled diabetic, 60 years of age, presented in a state of diabetic acidosis with spreading infective gangrene of the left great toe and first web space. No arterial pulses could be felt at the knee or the ankle. After a short period of intensive therapy with insulin and antibiotics, she was subjected to operation, at which an open amputation of the great toe was performed. Removal of the toe revealed a foul abscess in the first interosseous compartment. This was widely drained, and the bulk of the necrotic tissue was removed. The second toe, whose blood supply was precarious, was amputated, and the shafts of the first and second metatarsals were resected sub-periosteally until they were no longer visible in the wound. The wound was loosely packed, and was dressed with dilute Eusol for thirteen days. It was then clear that although the original operation had controlled the spread of infection, and had greatly improved the condition of the foot generally, persistent sloughs were preventing complete resolution and healing. A second operation was performed, at which all soft tissue sloughs were carefully dissected away. After a further twenty-one days, only a small, clean granulating area remained unhealed, and pinch grafts were applied to accelerate closure. Post-operative oedema was a problem, but was controlled by bandaging, and the patient was able to walk again ten weeks after operation.

Because infection was the major cause of gangrene, and fairly brisk bleeding was observed at operation, this patient has a good prognosis, provided she observes proper foot care, and keeps her diabetes under strict control.

Case 3

Mrs. H., a diabetic, 62 years of age, developed a fulminating infection of the left second toe, from which *clostridium Welchii* and *staphylococcus aureus* were cultured. Intensive chemotherapy appeared to control spread of the infection, but some slight encroachment on to the sole was found under the toe, where the flexor tendon was exposed. About two inches away, on the sole of the foot, was an abscess of the plantar fascia. At operation, this abscess was found to communicate with the toe along the flexor tendon, and the whole area was laid open by amputation of the toe, using a raquet incision with its handle extending through the plantar abscess. The distal one-half of the second metatarsal bone was resected, sub-periosteally, the involved tendons were radically excised, and all exposed fibrous tissue was carefully dissected away. There was virtually no deep abscess in the foot in this case, and the wound edges were allowed to fall together without suture. Prior to operation, a strong dorsalis pedis pulse was palpable, and bleeding at and after operation was freer than is usual in these cases. Healing was otherwise uneventful, with an almost linear scar, and hanging exercises were commenced within twenty-one weeks of operation. This case has a good prognosis (Figs. III and IV).

Case 4

Mr. W., a diabetic, 68 years of age, had already lost the great toe of the left foot for diabetic gangrene. He developed moist gangrene of the third toe, and was found to have a perforating ulcer under the head of the corresponding metatarsal bone. Chemotherapy localized the infection to the toe, but it clearly required amputation. X-ray of the foot revealed a destructive arthritis of the third metatarso-phalangeal joint, and therefore metatarsal resection was planned. This was carried out through a raquet incision which embraced the perforating ulcer. Septic thrombosis in the digital vessels to the third toe was clearly visible at the level of the ulcer, and the flexor tendons were necrotic. These tendons, and exposed fibrous tissues were carefully dissected away, and the distal half of the third metatarsal bone was resected. The edges of the wound fell together without suture. Healing took place with an almost linear scar within fourteen days, and the patient was walking well within thirty days of operation.

Fig. VII

Fig. VIII

FIGS. VII and VIII. Perforating ulcer of sole and gangrenous ulcer on great toe. Successful metatarsal resection (Case 6).

Case 5

Mr. J., a diabetic, 67 years of age, presented with recurrent episodes of infection in a perforating ulcer on the dorsolateral aspect of the left fifth toe. Clinical and radiological examination revealed a destructive arthritis of the fifth metatarso-phalangeal joint, and metatarsal resection was advised to forestall the development of serious infection in the foot. This was carried out as an interval operation after the infection had been almost completely controlled by chemotherapy. Lumbar sympathectomy was performed to improve the cutaneous circulation, and at the end of this operation the fifth toe and part of the fifth metatarsal bone were amputated through a raquet incision, including the ulcer. The wound healed slowly but well, and the patient was able to walk well within thirty-five days of the operation.

Case 6

Similar to Case 1. Illustrated by Figs. VII and VIII.

Three cases came to amputation of the leg.

Case 1

Mr. L., 59 years of age, presented with gangrene spreading from the fifth toe. This was dry rather than moist gangrene, and the circulation of the foot was admittedly poor. Nevertheless, the initial result of a metatarsal resection appeared to be favourable, and the wound was almost healed when he was transferred to a convalescent hospital. Twenty days later

he was readmitted in a state of diabetic acidosis, with acute spreading cellulitis and gangrene of the foot, extending upwards from the suture line, and evidence of a deep abscess at the ankle. Below knee amputation with open flaps was performed, and satisfactory closure followed delayed primary suture performed five days later. Dissection of the specimen revealed that there had been extensive spread of infection along tendons. Clearly the original drainage and resection had been too timid. This was only the second case in the series, and an attempt at loose closure with stainless steel sutures had been made. It is very likely that this was a factor in the spread of infection, and suture of the wound was abandoned thereafter in favour of open drainage. It is now felt that failure of the wound edges to fall together is an indication for removal of more bone, rather than for an attempt to draw these edges together with sutures.

Case 2

Mr. H., aged 72 years, presented with perforating ulcers under the heads of the first and fifth metatarsal bones. There was an area of cellulitis around the former. The infection appeared to be subsiding under the influence of a course of chemotherapy, and as X-ray showed no signs of infection in the first metatarsophalangeal joint, this treatment was continued. Fourteen days later the ulcers appeared to have healed, but within a month, there was an acute exacerbation of infection, and a further X-ray showed extensive destructive arthritis of the joint. A large abscess extending through the plantar fascia as far as the instep was drained, and although this considerably alleviated the infection, it soon became apparent that the small tarsal joints were involved, and an above-knee amputation was performed. In this case, the extent of the deep infection was not appreciated until too late, and a false sense of security was induced by the apparently successful control of the infection by chemotherapy. This patient required a variety of antibiotics in the course of his treatment, and resistant organisms were a real problem in the control of infection which developed in his amputation stump, and actually caused secondary haemorrhage requiring re-amputation.

One is tempted to think that this foot might have been saved if metatarsal resection had been performed when the patient was first seen. This is not an easy decision to make, for an elderly patient does not lightly enter hospital and undergo operation under general anaesthesia when his infection seems to be all but eliminated.

Case 3

Mrs. K., aged 70 years, had been under observation for over nine months for dry gangrene of the inner three toes of the right foot. She had not put the foot to the ground in this time, and finally, in an attempt to resolve this situation, simple nibbling away of the dead tissue was performed under light general anaesthesia. No dissection of living tissue was attempted, but after operation there was no sign of healing, and necrosis of the skin steadily spread on to the foot. This case was clearly unsuitable for any form of local amputation, and above-knee amputation was performed.

DISCUSSION

The advantages conferred on the patient and his relatives by the successful outcome of such procedures are obvious, and need not be discussed further. Selection of suitable case is not always easy, and while patients with obvious and extensive dry gangrene, and marked postural colour changes are clearly unsuitable, more than once surprising results have been achieved in border-line cases, whose gangrene was predominantly dry, but was confined to one or two toes, and the skin immediately adjacent. It must be remembered that many of these patients are destined to die of a cerebral vascular accident, or some other unrelated cause, within a relatively short period, and even if this is only six months, it is better spent walking than in occupying a bed in hospital or at home.

There can be no doubt that the younger the patient, and the greater the infective factor in the gangrene, the more strenuously should one aim at a conservative amputation.

Most cases fall into a large intermediate group, in which both infection and atheroma operate. It is recommended that this group should be offered the conservative operation described above. Some failures are inevitable, but a good proportion of successes can be expected. Even the unsuccessful case derives some benefit from the operation. The infected case, in which amputation is finally necessary, has a good chance of a below-knee amputation, which is of some importance to the patient who is likely to be able to use a prosthesis. The patient who steadfastly declines a major amputation which is clearly inevitable, can be subjected to this operation without risk, and may well approach the final decision with more insight and resignation when the last possible conservative procedure has been tried without succes.

It cannot be denied that weeks, or even months, may elapse before the final result is known, and both the patient and his medical attendants must be prepared for the tedium

of slow healing, the prespect of one or more revision operations, and the knowledge that the dividing line between success and failure is a very fine one. The surgeon must be quite frank in his discussions with the patient, whose co-operation, confidence and enthusiasm are of the greatest importance to a successful result. These are rarely lacking while any faint hope of success remains.

SUMMARY

1. The problem of conservative amputation in the diabetic is discussed.
2. The pathology of some common infective and ischaemic lesions of the feet of diabetics is described.
3. The technique of conservative amputation in such cases, with special reference to metatarsal resection, is described.
4. Case histories, selected to illustrate the variety of problems which may present to the surgeon, are given.
5. The selection of cases, and some aspects of prognosis, are briefly discussed.

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PORTAL HYPERTENSION

A CONSEQUENCE OF BILIARY CIRRHOSIS

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IT is commonly held that obstruction to the portal circulation is a rare complication of biliary cirrhosis. Thus, in one series of 240 cases of biliary cirrhosis coming to post-mortem examination, oesophageal varices were found in 2 cases only, an incidence of 0.83 per cent. (Gibson and Robertson, 1939). Himsworth (1950) mentions portal venous obstruction in association with biliary cirrhosis, but only as a terminal event.

Within recent years only 4 cases of portal hypertension due to extra-hepatic biliary obstruction have been reported. In neither of the 2 cases recorded by Brown and Choisser (1951) were oesophageal varices demonstrated although ascites was a features of both. Baker, Jones, and Hazelrigg (1950) published the account of a thyrotoxic woman aged 52 who died from a massive gastro-intestinal haemorrhage three months after the surgical repair of a stricture of the common bile duct. Post-mortem examination revealed a severe degree of biliary cirrhosis and oesophageal varices which had been the cause of the fatal haemorrhage. The story related by Ellis and Holman (1955) is strikingly similar to that of the first patient discussed below. Theirs concerned a woman aged 40 who had required two reconstructive operations on a severed common bile duct and was admitted five months after the second operation with melaena and haematemesis. Oesophageal varices were diagnosed as the cause of the bleeding, and a spleno-renal anastomosis undertaken as treatment. Portal vein pressure as measured at operation fell from 49 cms. of water to 29 cms. of water after the anastomosis. A third reconstruction of the common duct became necessary two years later owing to the recurrence of obstructive symptoms, but in spite of this she remained well up to the time of writing. A liver biopsy taken at the time of the first reconstructive operation showed chronic obstructive cholangitis. A second biopsy about one year later, at the time of the spleno-renal anastomosis, demonstrated a considerable increase in fibrous connective tissue in the portal areas.

The purpose of this paper is to report 2 further cases of portal hypertension resulting from surgical conditions of the extra-hepatic biliary tract. It would appear that this complication is not as rare as had been supposed. A comparison of the clinical and pathological features of biliary cirrhosis and alcoholic cirrhosis conducted at the Mayo Clinic revealed that haemorrhage from oesophageal varices had occurred in a significant number of patients with biliary cirrhosis (5 out of 54) though a much commoner event in those with alcoholic cirrhosis (22 out of 27). Furthermore it was in biliary cirrhosis of an advanced degree that portal venous obstruction tended to occur (Doehlert, Baggenstoss and Cain, 1955). Their findings would suggest that although portal hypertension may not infrequently complicate biliary cirrhosis, it seldom assumes the importance that it does in cirrhosis of the Laennec type. It is overshadowed by the earlier and graver effects of biliary obstruction.

Case 1

This patient's sorry tale (N.L., aged 31) started with a cholecystectomy in 1952. Following the operation she suffered considerable pain in the right upper abdomen and became jaundiced. For six months no further action was taken until she consulted a second surgeon who undertook an exploration of the common bile duct forthwith. In his words "I could find no trace of the common duct. Finally by needle and syringe I discovered some white bile in the portal fissure and managed to drain the upper and very short end of the duct. Some weeks later I explored again and united the duodenum to the upper end of the duct over a T-tube which was left in for some months."

Following the choledocho-duodenostomy she remained moderately well despite recurrent attacks of upper adbominal pain, fever, and jaundice which responded well to short courses of chloromycetin. On 4th July, 1955, she suddenly felt faint and had

to lie down. Three hours later she had a melaena and then vomited six ounces of altered blood. She was admitted to Green Lane Hospital on the same day, and was described by the house surgeon as a "well-nourished woman of rather peculiar colour—greyish pallor with a slight icteric tinge." The liver was noted to be palpable 3 inches below the costal margin and to have an irregular lower edge. The spleen was also considerably enlarged, the lower pole reaching well down into the left iliac fossa.

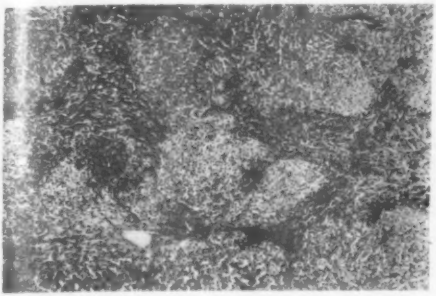

FIG. I. Showing fibrosis confining single lobules, and marked infiltration with inflammatory cells. (x 45)

Her condition improved with blood transfusion though the benefit of the blood was diminished by transfusion reactions and the laboratory experienced great difficulty in finding compatible blood. A total of 12 pints of blood was given over several days in order to raise the haemoglobin from 10.7 gms. per 100 m.l. to 12 gms. per 100 m.l., a fact which was partly explicable by the continuing blood loss but suggested that hypersplenism may have been playing a part.

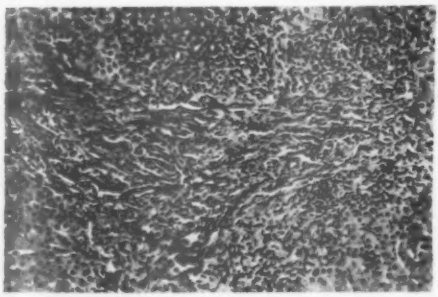

FIG. II. Numerous small bile ducts are seen in the fibrous tissue, and inflammatory cells many of which are polymorphonuclear. (x 135)

A plain film of the chest on the 11th July suggested the possibility of a subphrenic collection and an exploration of the upper abdomen was performed six days later. The findings were as follows: "The liver was encased in a cocoon of adhesions and was extremely hard. The spleen also was large and firm. An extra-hepatic collection of bile-stained fluid was found between the right lobe and the lateral abdominal wall (approximately 1 pint) and drained." A liver biopsy (Figs. I and II) was taken and the histological report was as follows: "Section shows a marked fibrosis of the monolobular type, each lobule being confined by more or less dense fibrous tissue in which numerous small bile ducts are found. There is no evidence of obstructive dilatation of the ducts. Scattered inflammatory cells of both acute and chronic types are present in the interstitial biliary tract tissue, suggesting a cholangitis. The capsule of the liver is thickened and densely fibrotic."

FIG. III. Barium swallow showing moderate varices in lower third of oesophagus in Case 1.

Some improvement after this operation was not sustained owing to the continuation of haemorrhages and a barium swallow on 16th August confirmed the presence of a small oesophageal varices (Fig. III). It was decided that an attempt would have to be made to perform a spleno-renal anastomosis or if this proved impracticable, to interrupt the varices responsible for the bleeding. This operation was undertaken on 14th September by Mr. Douglas Robb. Through a left thoraco-abdominal incision a greatly enlarged spleen (weighing 130 gms.) was exposed with an engorged splenic vein of 1 cm. in diameter. After splenectomy the vein collapsed to about half its original size, and the pressure as measured at this stage was 31 cms. of water. This was considered too low a pressure for a successful spleno-renal

anastomosis to be established. Accordingly a transection of the stomach just below the cardia was undertaken with ligation of the dilated veins and end to end reconstitution. She made an uneventful recovery from this operation and up to the time of writing four months later is maintaining good health, although still clinically jaundiced (serum bilirubin 1.8 mgms. per 100 m.l.).

The laboratory findings of interest were:—A persistently raised serum bilirubin reaching a highest level of 4.8 mgms. per 100 m.l. A fluctuating serum protein level with normal albumin-globulin ratio but with total protein falling to a lowest level of 5.2 gms. per 100 m.l. Normal empirical liver function tests. A serum cholesterol level of 210 mgms. per 100 m.l.

Case 2

M. T., aged 73. This woman had a cholecystectomy for cholelithiasis in November, 1947. Following the operation she suffered some nausea, dyspepsia, and pain in the epigastrium, and failed to regain her previously good health. In July, 1949, she developed sever colicky pain in the upper abdomen and slight jaundice, in spite of having been on a low-fat diet. She was re-admitted to hospital in September of that year and the common bile duct was explored and found to contain granular debris and fragments of stone. The duct was irrigated and T-tube drainage established for one month. No cholangiogram was performed.

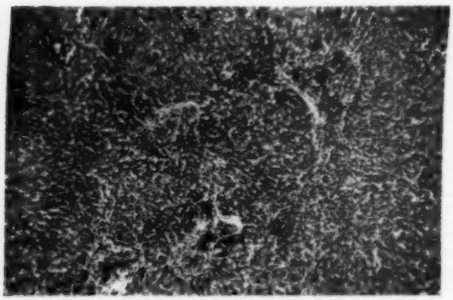

FIG. IV. Another example of perilobular fibrosis and diffuse inflammatory cell infiltration of the portal tracts. (x 45)

She continued to suffer recurreat attacks of pain in the upper abdomen with occasional vomiting, and was admitted to another hospital for a second exploration of the common bile duct. The febrile attacks still persisted, however, and became more severe six months prior to her last admission to Green Lane Hospital in September, 1953. At this time she was found to be a desperately ill, frail, slightly jaundiced old lady. Her liver was not palpable but some tenderness was elicited over the biliary tract region. Clay coloured faeces were found on rectal examination. The patient succumbed on the day after admission and post-mortem examination yielded the following findings: "Thin elderly woman with moderate generalized jaundice. Old scars on abdomen. Common bile duct greatly thickened and dilated to give a lumen of 2 cms. diameter, and filled with large and small stones which were impacted tightly. The duct narrowed in the pancreas and no distinct opening into the duodenum could be found. The liver showed irregular scarring and when cut revealed a widespread biliary cirrhosis. The oesophageal veins were varicose and a small rupture was located in a vein near the cardiac sphincter. The stomach contained about two pints of fresh blood clot." The cause of death was stated to be haemorrhage from oesophageal varices due to portal hypertension on the basis of an advanced biliary cirrhosis. A microscopical section of liver taken at post-mortem examination (Figs. IV and V) was described thus: "Section of the liver shows a perilobular fibrosis with distension of the bile ducts and a diffuse chronic inflammatory cell infiltration of the portal tracts. In some areas there is a considerable proliferation of the smaller bile ducts. Inspissated bile granules are seen between liver cells in the bile canaliculi. There is also a diffuse fatty infiltration of moderate degree in all areas. The picture is consistent with a biliary cirrhosis."

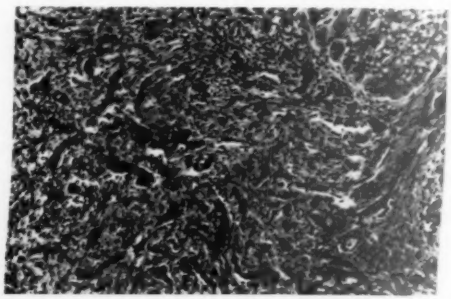

FIG. V. Marked proliferation of small bile ducts, chronic inflammation, and fatty infiltration of parenchymal cells. (x 135)

DISCUSSION

For the purpose of this discussion it is only necessary to mention in passing the two main varieties of biliary cirrhosis. The primary form described originally by Hanot and bearing his name, may be due to intra-hepatic obstruction of the finer bile passages, but does not concern us directly and will not be further considered. The secondary form is due to extra-hepatic obstruction of the biliary system from any of the known causes such as calculous disease, carcinoma, and stricture either surgically produced or inflammatory. The effect on the liver depends on whether the stasis is followed by infection as is the rule when the obstruction is intra-luminal or whether the retained bile remains sterile as may happen for example when the obstruction is due to the extra-luminal pressure of

malignant glands. Thus, the effects of pure obstruction are dilatation of the biliary channels with proliferation and tortuosity (hydrohepatosis), destruction of liver cells, and their replacement by scar tissue. There is less fibrosis and cellular regeneration than in portal cirrhosis of the Laennec type and regenerative nodules are small and irregular, only partly replacing the parenchyma. (In portal cirrhosis the nodules are clearly demarcated, round or elliptical, and almost entirely replace normal liver structure.)

If infection is an important factor, as is usually the case, the dilatation of the biliary ductules is less marked, and there is a varying degree of cellular infiltration and fibrosis in the portal areas. The typical inflammatory cells are lymphocytes and monocytes, although acute inflammatory cells may be numerous after a recent exacerbation of cholangitis.

It will be noticed that in both histories recounted here, there is a considerable time lag between the original insult to the common bile duct and the development of clinical portal hypertension. In Case 1 the interval was three years, and in Case 2 six years. In the case described by Ellis and Holman (1955) the lapse of time was one year, and in that described by Baker and others (1950) two years and three months. Furthermore it would seem reasonable to suppose that the recurrent attacks of cholangitis to which the two cases here mentioned, and that of Ellis and Holman, were subjected, served to aggravate the obstruction to portal venous blood flow. These three histories also suggest that the severity of the obstruction is of importance. In each instance the patient was subjected to at least two corrective operations, and in Case 2 the advanced degree of the obstruction was verified at the post-mortem examination.

These observations pave the way for the assertion that biliary cirrhosis can lead to portal venous obstruction provided it is of severe degree, and sufficiently long-standing. The passage of time is only important in so far as it allows of aggravation of the cirrhosis by recurrent attacks of cholangitis. It is not possible on the evidence of two or three cases to attempt an explanation for the more frequent occurrence of portal hypertension in cirrhosis of the Laennec type, but it would not be out of place to observe that the pathological features of this condition which have been blamed for the development of venous obstruction are less marked in biliary cirrhosis. The histological differences as they are related to the theories of causation of portal hypertension may be tabulated thus:

Possible Causative Factor	*Histology*	
	Portal Cirrhosis	*Biliary Cirrhosis*
Contraction of fibrous connective tissue round blood vessels.	Dense regular inter-nodular bands of fibrous tissue.	Loose irregular bands of fibrous tissue between nodules.
Obliteration of vessels during necrosis of liver cells.	Extensive necrosis preceded by fatty metamorphosis. Little normal liver parenchyma remains.	Less extensive necrosis. Fatty change not usually a feature. Some normal liver parenchyma left.
Compression of veins by regenerative nodules.	Well outlined nodules often distorting veins.	Small irregular nodules seldom compressing veins.
Lateral compression of veins by dilatation of the biliary tree.	No dilatation of the biliary tree.	Bile stasis with dilatation of varying degree.

Of these factors the most important is probably compression of veins by regenerative nodules (Doehlert and others, 1955). The tendency to cellular regeneration, and the formation of these new nodules without due regard to the vascular anatomy is strong in portal cirrhosis, but inhibited in the presence of biliary stasis. Lateral compression of veins by dilatation of biliary channels (Counsellor and McIndoe, 1926) could not be an important factor in those livers which show only minimal dilatation of the biliary canaliculi, but striking predominance of

inflammatory changes. Perhaps in such cases we should be more impressed with the possibility of venous compression by the exudation accompanying acute exacerbations of cholangitis (Fig. II), an obstruction rendered permanent by the onset of thrombosis, or by the strangling effects of fibrosis.

SUMMARY

Two cases are described in which haemorrhage occurred from oesophageal varices due to portal hypertension on the basis of biliary cirrhosis. In each instance the cirrhosis was of the secondary type, being due to surgical damage to the common bile duct, and residual calculi in the extra-hepatic bile ducts respectively. Brief references are made to the experiences of other authors who have dealt with the same subject within recent years, and an explanation is ventured for the more common occurrence of portal hypertension in portal than in biliary cirrhosis.

ACKNOWLEDGEMENTS

I wish to thank Mr. Douglas Robb for permission to report these two case histories, both patients having been under his care, and Dr. Stephen Williams for his help with the pathological aspects of the condition under discussion.

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MOLLUSCUM SEBACEUM

By J. T. Hueston

Melbourne

A SHEEP in wolf's clothing is quite as intriguing as the reverse. A benign lesion which, until recently, was universally regarded as maligant has aroused wide interest. Since its first description twenty years ago, pathologists and dermatologists have become increasingly aware of molluscum sebaceum as an entity, but with surgeons and radiotherapists the strong clinical resemblance to malignancy has prevented any example from proving its innocence. In fact, the surgical literature is surprisingly lacking in recognition of a common benign lesion which most surgeons have often removed radically as a carcinoma.

Historical

The spectacular rapidly growing skin lesion we know as molluscum sebaceum was singled out long ago as one of the less dangerous forms of epithelioma. Thus Savatard (1920), in a plea for the early diagnosis of skin cancer, referred to the "button epithelioma" which may attain the size of a pea within two or three weeks and the frontispiece to his paper illustrates a typical molluscum sebaceum. O'Donovan (1920) in discussing skin cancer among tar workers illustrates two examples of large tumours arising within two months and showing all the features of molluscum sebaceum. Such an association with tar workers has been common in patients with this condition (Calnan and Haber, 1955) and the "tar wart" with its frequently benign clinical course, has in many cases been identified with the molluscum sebaceum (Klaber, 1936).

While Dupont (1930) has been credited with first recognizing the true nature of this lesion under the term *kysté sebacé atypique*, its first description in British literature was the very clear correlation of the clinical and histological features by MacCormac and Scarff (1936). The term molluscum sebaceum was suggested by these workers from the superficial resemblance of the histology both to molluscum contagiosum and to a sebaceous cyst. Spontaneous regression, confirming the essential innocence of this lesion, was recorded by Musso (1950) and Fouracres and Whittick (1953). Finally Beare (1955) has indicated the common occurrence of molluscum sebaceum by collecting 122 cases in six years.

Terminology

Molluscum sebaceum, suggested by MacCormac and Scarff, has been criticized on the grounds that there is little sebaceous element and that the term has at times been used as a synonym for molluscum contagiosum. However, the alternative *kerato-acanthoma* of Rook and Whimster (1950) could just as easily apply to the common verruca; while the cumbersome *molluscum pseudocarcinomatosum* (Lancet, 1953), although apt, can hardly be accepted for everyday use.

The basic shell-like structure of the lesion suggests the prefix *molluscum* and, although *keratosum* might be more appropriate than *sebaceum*, it will lessen confusion if we retain the original term under which this condition has become recognized.

Incidence

Of most practical importance is the relative frequency of occurrence of the benign molluscum sebaceum to squamous-cell carcinoma with which it may be confused. Unfortunately a comprehensive series is difficult to obtain owing to the distribution of skin tumours over a number of hospital departments, including dermatology, radiotherapy, general surgical and plastic surgery. The clinical diagnosis of these skin tumours has varied with the familiarity of the clinician with molluscum sebaceum and no accurate figures can be compiled.

In the past fourteen months the present author has examined 14 examples of molluscum sebaceum of which 12 were proven histologically and 2 resolved spontaneously;

one patient developed 2 separate tumours within three months. During the same period only 7 primary purely squamous-cell carcinomata of the skin (excluding lip and mucous membranes) have been observed. This must not be interpreted as a claim that molluscum sebaceum is twice as common as epithelioma. The significance lies in the high incidence once familiarity with the tumour is established. This familiarity is usually acquired the hard way and it is freely confessed that the first four mollusca excised personally were being treated with a firm clinical conviction that they were carcinomata. The histological reports in these cases indicated that some reconsideration of the macroscopic features might lead to a more accurate clinical diagnosis.

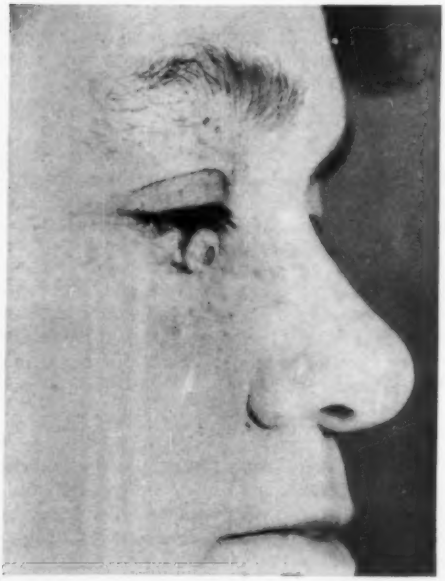

FIG. I. Molluscum sebaceum of lower eyelid which reached this size in four weeks. The appearance is typical, with pale ballooned margins and an adherent keratin plug. This lesion was removed by simple shaving off level with the skin surface.

Two-thirds of these patients with molluscum sebaceum were over sixty years old; the youngest was a woman aged thirty-eight years. There can be no significance in the fact that 8 patients were male and 5 female, although all 4 hand lesions being in men may have some etiological significance. All tumours seen have been on the exposed skin, 10 on the head and 4 on the hand. This limitation to the exposed parts has been a feature of all recorded cases except one reported near the anus by Rook and Whimster (1950). No case has been recorded of molluscum sebaceum arising from a mucosal surface and the lesion illustrated on the lip (Fig. II) was noted to commence on the adjacent hair-bearing skin.

CLINICAL FEATURES

Molluscum sebaceum has a natural history in three stages: growth, maturation and resolution.

FIG. II. Molluscum sebaceum of the lower lip of six weeks duration.

Growth phase

In many cases the patient describes how the lesion started as a pimple, slightly reddened but not tender. From this appearance there is a rapid enlargement so that within two or three weeks the lesion is often one centimetre or more in diameter. This growth phase lasts up to four or five weeks by which time the maximum size of the tumour is reached. In only 3 cases of those seen personally was the lesion less than one centimetre in diameter, whereas 2 tumours on the back of the hand were three centimetres across. In contrast to the tumour size was the duration of these lesions; the average when seen being less than two months.

This rapidity of growth, with the high size-duration ratio is the most important single feature in identification of the molluscum sebaceum.

Maturation

After its initial rapid enlargement the lesion remains about the same size for some weeks. Histologically there is a progressive conversion during this time of the central cellular mass to keratin with little external change. The length of this phase depends largely on the rate of this keratinizing process but it usually lasts four to six weeks.

FIG. III. Large molluscum sebaceum of eight weeks duration on dorsum of hand. The contour is typical.

The maturing tumour has a very characteristic appearance (Figs. I to V). The margins rise abruptly from normal skin up to eight or ten millimetres often bulging out to give an almost spherical contour. This "ballooning" of the tumour margins is characteristic of molluscum sebaceum and most helpful in diagnosis.

The base of the tumour shows no evidence of deeper fixation than the dermis. Any lesion therefore which fails to move with the skin cannot be molluscum sebaceum.

The apex of the maturing lesion carries a keratinous plug. Being produced within the bulging outer epidermal shell of the tumour, the keratin protrudes through a crater on its summit and may be removed piecemeal to show the typical papillary internal structure of the molluscum (Fig. IV). Finlay (1953) describes the production of a prominent horn in some cases.

Many mature tumours show three colour zones — a reddened base, pale pink to white bulging sides and a brown adherent keratin plug on the summit (Fig. V).

Resolution

Those tumours left untreated eventually drop off, leaving a small reddened patch with irregular slightly raised margins (Fig. VI) which ultimately settles down to a pale slightly depressed scar. The approach of separation may be suggested clinically by some shrinkage due to the increasing proportion of keratinous material within the epidermal crater. Eventually the outer shell of stretched epidermis is no longer strong enough to support the central keratin mass and either the whole is dislodged accidentally by the patient or the keratin falls out piecemeal. The slightly raised edge seen after dislodging the mass represents the base of the former epidermal shell and ultimately becomes quite flat.

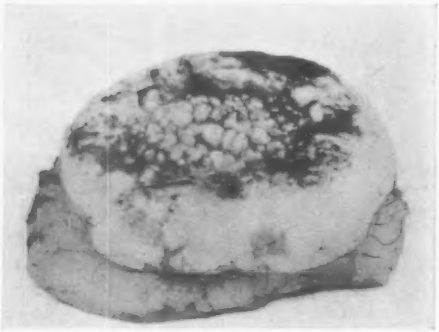

FIG. IV. Close-up view of excised lesion from Fig. III with the keratin plug removed to show the papillary internal architecture and undermined crater edge.

Pain is uncommon but was present in two cases seen, each being in this resolving phase and associated with a semi-purulent discharge. Such infection of a resolving molluscum is consistent with the structure of this late phase when the vascularity is poorest.

HISTOLOGY

The basic structure of molluscum sebaceum is a raised shell of normal epidermis stretched over an exceedingly papillary epidermal mass which is becoming progressively

cornified (Fig. VII). This basic structural pattern of the tumour along with failure to penetrate deeper than the dermis are the most characteristic histological features.

FIG. V. Mature lesion of eight weeks standing showing the three colour zones—reddened base, pale bulging sides and brown adherent keratin plug.

At the crater margin the stretched out epidermis turns in abruptly, becoming the hyperplastic papillary lining of the crater (Figs. VII to IX). This lining consists of very well-differentiated prickle cell masses so that there is never a true ulcer present. Depending on the maturity of the tumour, the papillary prickle cell masses are becoming more and more cornified. In the late stages, most of the lesion consists of a keratinous mass enclosed by only a thin shell of epithelium (Fig. IX). While the bulk of the central plug is usually parakeratin, with evidence of nuclei persisting for some time, most tumours have areas displaying a distinct granular layer (Fig. X), designating the production of true keratin which is exceedingly rare in squamous-cell carcinoma and a distinguishing histological feature of molluscum sebaceum. The deep surface of the hyperplastic prickle cell mass is lobular, in mature lesions often showing a well-developed intact basal layer. A characteristic is the regular depth of this surface of the lesion (Fig. VII). In no part does the deep aspect penetrate deeper than the dermis so that sweat glands are usually visible deep to the tumour although its total height may be nine or ten millimetres above the free surface. An apt term to describe this hyperplastic mass within the skin and bulging on to the surface is Tait Smith's (1955) "space-occupying lesion of the skin."

FIG. VI. The reddened base left by a spontaneously healing molluscum sebaceum.

The dermis shows an active inflammatory change in the growth phase with mainly small round cells but some polymorphs aggregated in relation to the hyperplastic epithelial masses. In the later phases the inflammatory change becomes less and foreign body giant cells may be seen.

The principal difficulty in histological diagnosis from squamous-cell carcinoma arises when the growing margins of the hyperplastic masses are examined under high-power. Mitotic figures are occasionally seen and the basal cell layer may not be distinguishable, so that in fact it may be impossible

to differentiate this region from carcinoma. This is simply because in the actively growing phase of molluscum sebaceum the epithelial masses must of necessity present a similar morphological appearance to the actively growing cells of a carcinoma. Neither the cells nor their mode of division is different, only the overall *pattern* of growth distinguishes benign from malignant and the differential diagnosis depends on integrating the whole histological picture. The mature lesion shows masses of prickle cells regular in arrangement, size, shape and staining,, as distinct from the irregularity of arrangement, size, shape and staining seen in squamous-cell carcinoma with a comparable rate of growth.

FIG. VII. Section of the margin of lesion shown in Figs. III and IV, illustrating how the central hyperplastic mass produces the "ballooned" contour. The very superficial nature of the proliferation is well shown with no penetration deeper than dermis. (x 7)

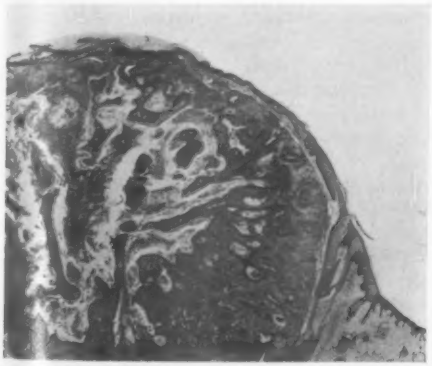

FIG. VIII. Section of the margin of a mature molluscum sebaceum, showing how the skin is drawn up over the mass and turns in abruptly at the crater edge to become continuous with the hyperplastic lining. (x 16)

The importance of correlating the clinical history with the histological picture before arriving at a diagnosis is obvious. No squamous-cell carcinoma which produces a mass over one centimetre diameter in four weeks will show the high degree of differentiation seen in this condition. Stewart (1954) recommends that every pathologist, before diagnosing squamous-cell carcinoma, should ask himself *Could this be a molluscum sebaceum?*

FIG. IX. Section of a resolving molluscum sebaceum. The crater edge is distinct but the lining epithelium is flattened. The contents of the lesion have become completely converted to keratin and para-keratin. (x 16)

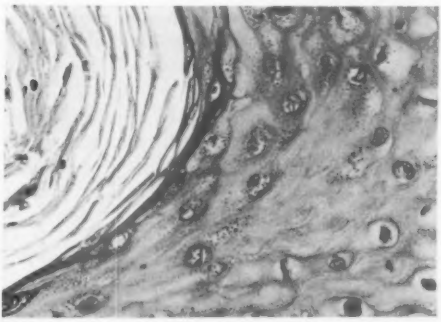

FIG. X. High power of a maturing lesion showing well developed granular layer which is unusual in skin carcinoma. (x 760)

DISCUSSION

The essential nature of the lesion appears to be a regional mass hyperplasia of epidermal and dermal epithelial structures. The initial lesion, often described as a pimple, represents the early accumulation of epithelial

masses within the superficial dermis with the accompanying small round cell aggregation common to all rapid epithelial growth. This hyperplasia of hair follicles and sweat glands proceeds with no true infiltration of the dermis so that the deepest parts of the tumour lie no deeper than sweat gland level. The progressive cornification of the resultant papillary masses represents an ageing of the squamous epithelium which, after active growth has ceased, gradually replaces the whole tumour mass until this is dislodged.

The stimulus to start off this hyperplasia is not known, but many patients give a history of some preceding trivial local injury. Thus a rose-thorn prick was blamed by two patients in this series, a snick with a razor, a superficial burn, and one had diathermy to a common wart in the same area. Tar warts are said to arise in areas locally burned by splashed tar rather than from a patch of dermatitis. Beare (1955) also describes the rapid growth of one molluscum after the stimulus of surgical interference.

Certainly the natural history of a proliferative growth phase lasting three or four weeks and followed by progressive resolution and healing suggests a transient local stimulus. Failing any demonstrable local cause it was inevitable that a virus should be postulated. However, being virtually confined to the exposed parts of the skin and predominantly in elderly people, it is possible that there is a general change in the skin with age, accentuated by exposure to sunlight, which renders it likely to active local hyperplasia of this type with a number of different non-specific stimuli.

The relationship of molluscum sebaceum to the self-healing epitheliomata recorded in the literature has aroused interest. It certainly seems that the tumour-like keratoses of Poth (1932) and Fliegelmann and Lovemann (1952) were identical with molluscum sebaceum and it is interesting that in both cases sunlight was considered an important precipitating cause. However, in both cases the lesions were multiple, which is uncommon in molluscum sebaceum where two or three tumours may occur but rarely at the same time. The condition described by Ferguson Smith (1934) as multiple self-healing epitheliomata has a superficial resemblance to multiple molluscum sebaceum but both the macroscopic and microscopic features are more those of carcinoma, with true invasion in some areas. Such a case was examined recently in Glasgow by courtesy of Mr. J. Scott Tough. This patient had ultimately developed a carcinoma of the left ear which did not resolve in the manner of all his previous lesions.

Molluscum sebaceum is without doubt a common condition; in fact, one ventures to suggest as common in this country as pure squamous-cell carcinoma of the skin. That such a benign self-healing lesion has, until recently, been masquerading as epithelioma raises important issues. If a significant proportion of the lesions treated either by surgery or radiotherapy as malignant, would in fact have healed spontaneously, then some review is necessary of the past claims for the success of either method in the treatment of skin carcinoma.

The question also arises of the best plan of treatment once molluscum sebaceum is diagnosed. Beare (1955), who has recorded the largest series of cases so far, recommends a biopsy followed by shaving off the lesion at skin level. However, once molluscum sebaceum is suspected from the appearance and high size/duration ratio of the tumour, complete local excision would seem preferable to confirm the diagnosis histologically. Surgical excision produces a better scar than the pale depressed scar left after spontaneous or radiation-induced resolution. Two cases, including one illustrated on the eyelid (Fig. 1), have been simply shaved off level with the skin surface and this alternative may be reserved for such areas when the clinical diagnosis is definite. There should be no hesitation in radical excision of doubtful lesions, because if there is any doubt at all the odds favour the malignant tumour. Once familiar with the clinical features of molluscum sebaceum, the diagnosis can usually be made with sufficient confidence to allow a limited local excision.

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INTERPARIETAL HERNIA

By Vernon Barling

Sydney

INTERPARIETAL hernia has been the subject of sporadic comment in the literature of hernia over the last century. It is a rare condition so that a surgeon sees few such cases. When they are seen, lack of familiarity is the cause of misdiagnosis and mismanagement. It is therefore considered worthwhile to discuss the subject once more, the writer having seen a case recently in which a patient with interstitial hernia had been told that he had an absence of his lower abdominal wall and that he would have to put up with his discomfort for the rest of his life. He had an irreducible interstitial hernia between the external and internal oblique muscles of the abdomen which was readily cured.

Definition

An interparietal hernia has a hernial sac (usually in the inguinal region) which passes between the layers of the anterior abdominal wall. The sac may or may not be associated with or communicate with a sac in the common situation in the inguinal canal passing down into the scrotum with the spermatic cord. The sac may be unilocular or bilocular.

Varieties

1. Properitoneal. In this variety the sac lies superficial to the peritoneum deep to the muscular layers of the abdominal wall; it forms about 20 per cent. of all interstitial herniae collected by Lower and Hicken (1931).

The sac usually takes the form of a diverticulum from a femoral or inguinal hernia—hence the subtitles of

(a) Inguino-properitoneal;

(b) Cruro-properitoneal.

Moynihan (1900) and Halstead (1906) insisted that all properitoneal herniae are bilocular, have sacs communicating with each other and open by a common opening into the peritoneal cavity.

However, there are numerous reports of a single sac alone being found after most careful investigation and there being no associated femoral nor inguinal heria (Göbell, 1900). Also there are cases which support the view that

(a) two separate properitoneal sacs may co-exist (Howlett, 1902);

(b) the inguinal or femoral hernial sac may be quite distinct from the properitoneal sac (Wagner, 1834; Englisch, 1885; Brunner, 1889).

2. Intermuscular or Interstitial. In this form the hernial sac passes between the muscular layers of the anterior abdominal wall or into the substance of a single muscle (internal oblique). This is the commonest variety (60 per cent. of Lower and Hicken's cases).

The commonest situation is between the internal and external oblique muscles of the abdomen. Moynihan claims that this is the only space that such herniae can occupy. However, authenticated reports indicate that a deeper level can be taken (Göbell, 1900). Goyrand (1835) states that the sac of an interstitial hernia that he has described was actually enclosed by the fibres of the internal oblique muscle.

The sac again though usually bilocular and associated with an inguinal hernial sac may be single and not so associated. It may even be completely extra-inguinal in that it leaves the peritoneal cavity above the inguinal canal.

3. Inguino-superficial. In this variety a hernial sac passes through the external ring of the inguinal canal and then expands subcutaneously in the anterior abdominal wall or thigh (20 per cent. of Lower and Hicken's cases).

Bilocular sacs are more common than unilocular.

Historical

These herniae were recognized in 1661 by Bartholin; Goyrand, in 1836, first used the term "interstitial"; Krönlein, in 1875, coined

the term "inguino-superficial," and Sir Astley Cooper is credited with the first successful operation for strangulated interstitial hernia in 1812.

AETIOLOGY

1. *Properitoneal*

As with the other two varieties, there are two main hypotheses of their formation:

(a) Mechanical:

Their origin can be attributed to some mechanical obstruction to the descent or reduction of an inguinal or femoral hernia with consequent sacculation into the properitoneal layer. This mechanical obstruction has been said to occur with

(1) narrowing of the abdominal inguinal rings;

(2) wearing of trusses;

(3) maldescent of testicle;

(4) hydrocoele of canal or cord.

Eppinger (1891), in an intensive examination of the inguinal canal, considers that there are two weak regions in its constitution such as would favour the occurrence of interparietal herniae. The first of these lies in relationship to the initial third of the inguinal canal as the cord enters. It is in this region that properitoneal herniation would be favoured.

The second weak area is considered to be in the medial third just proximal to the external abdominal ring. This site supposedly predisposes to the origin of interstitial or intermuscular herniation.

Against a mechanical factor being universally present is, of course, the fact that two sacs are often present — each sac being completely separate from each other, and single sacs may be present without a coexistent inguinal or femoral hernia.

(b) Congenital:

Rokitansky (1845), Moynihan (1900) and Coughlin (1905) all described small peritoneal pouches in the region of the internal abdominal ring. Moynihan stated that these were present in 22 per cent. of necropsies and occurred in close proximity to the obliterated hypogastric artery. He considered that they could easily form properitoneal hernial sacs.

It seems likely that the origin from a congenital sac is most probable. Fusion of a congenital properitoneal sac with a congenital inguinal or femoral hernial sac could easily occur as enlargement of either or both occurred and so make it appear that the properitoneal sac was a diverticulum of the inguinal or femoral sac.

2. *Interstitial*

In the interstitial herniae a mechanical origin would seem more probable — except in the case of females and the very small proportion of cases not accompanied by an inguinal hernia and not associated with a testicular defect (abnormal descent occurs in 60-70 per cent. of these cases). In this small proportion a congenital sac may be postulated.

Macready (1893) stated that in cases of interstitial hernia without testicular abnormality he had observed a constant weakness of the muscles of the abdominal wall in the region below a horizontal line joining the anterior superior iliac spines. This is however much more likely to be an atrophy secondary to the pressure exerted on them by the interstitial hernia. He also is joined by Moynihan in drawing attention to the frequency of scrotal defects in these cases which may prevent testicular descent.

3. *Inguino-superficial*

In inguino-superficial herniae the association with an abnormally placed testicle is very high and with a high proportion, 75 per cent., of bilocular sacs (Göbell, 1900) makes a mechanical origin more probable. Again in the small proportion of monolocular cases and those not associated with ectopic testicles a congenital origin for the sac must be presumed.

In those cases (not associated with a congenitally performed sac) the origin would appear to be closely related to a congenital abnormality, that is, the occurrence of a hernial sac or the misplacement of a testicle. Hence mechanical factors when they do occur are secondary to a congenital defect and in this sense all cases of interparietal hernia could be considered congenital in origin.

ABSOLUTE INCIDENCE

This is difficult to estimate in the case of properitoneal herniae. It is probable that the incidence is much higher than suspected because even during an operation for an inguinal or femoral hernia a properitoneal sac may easily be missed. It would be even more difficult to recognize clinically. Indeed Moynihan claimed that it was impossible to recognize, on abdominal examination, that a properitoneal hernia was present. Hence the incidence quoted—1/5000 (Bull and Coley, 1893) is probably far below the real figure.

In the case of interstitial and superficial herniae the diagnosis is much more likely to be made clinically and here the incidence lies somewhere in the region of one case per thousand inguinal herniae (Langton, 1900).

In all varieties the incidence in the male predominates 3/1 in both properitoneal and interstitial and 14/1 in superficial herniae.

The age of incidence is younger in the male (30 to 40 years) than in the female (50 to 60 years).

DIAGNOSIS

This is more readily attained if the possibility of such a condition is borne in mind. In the case of properitoneal herniae nothing may be apparent on abdominal examination in the way of a lump, whereas in the other two forms of interparietal hernia a lump is obvious. As most cases present with intestinal obstruction due to encarceration or strangulation the correct diagnosis is readily made in the interstitial and superficial varieties. However, a lump in the iliac fossa when due to an irreducible superficial or interstitial hernia (without obstruction) may present diagnostic difficulties — more so if omentum alone be encarcerated and there be no associated testicular nor scrotal defects.

Strangulation of bowel may occur or continue following the apparent reduction of an encarcerated inguinal or femoral hernia—Moynihan considers that *reductio-en-masse* is in all cases an alteration in position of the strangulated bowel from an inguinal or femoral loculus to a properitoneal sac.

To summarize:

1. Ninety per cent. of cases present with acute intestinal obstruction.
2. Pain is localized in the supra-inguinal region.
3. A lump is palpable *only* in interstitial and superficial herniae and not in properitoneal herniae.
4. Abnormal positioning of the testicle is present in a high proportion of cases.
5. Diagnosis may be difficult or impossible when
   (a) no intestinal obstruction is present;
   (b) no lump is palpable or if the palpable lump contains encarcerated omentum;
   (c) no testicular nor scrotal abnormalities are present.
6. The mortality is high in properitoneal herniae particularly when obstruction persists after an apparent reduction of an encarcerated inguinal or femoral hernia. This mortality has been estimated at 80 per cent. (Torrey, 1888) and greater than 20 per cent. (Lower and Hicken).

TREATMENT

1. Immediate operation is most frequently necessary because of the high presentation as acute intestinal obstruction. Persistence of obstructive symptoms after reduction of a hernia or after prior herniorrhaphy should make one suspect the presence of a properitoneal sac and demands further operation.
2. At operation in dealing with the sac further loculi should be sought for — an abnormal position of the testicle may possibly be dealt with at the same time. Standard techniques of repair of the inguinal canal hold for these types of herniae, but a combined approach from an incision parallel to but higher than the one exposing the inguinal canal (i.e. combined abdomino-inguinal approach) will give a very much better exposure and enable the site of obstruction to be more clearly viewed.
3. Prophylactically it is recommended that at operation on all herniae in the inguinofemoral region the sac should be opened and a careful investigation made by palpation with a finger introduced into the sac in order to detect loculi of the sac

itself or the presence of other separate sacs — properitoneal particularly — and also direct inguinal, indirect inguinal and femoral sacs. This will be aided if the whole of the inguinal canal is freely exposed at operation.

SUMMARY AND CONCLUSIONS

1. Interparietal hernia is uncommon but probably occurs more frequently than is suspected. This is particularly true of the properitoneal variety.
2. Presenting usually as acute intestinal obstruction with a supra-inguinal swelling the diagnosis and treatment are straightforward.
3. In non-obstructed cases abnormalities in the position of the testicle will make diagnosis more certain.
4. Diagnosis may be difficult or impossible if
   (a) a properitoneal hernia (where there is no supra-inguinal lump) is present;
   (b) obstruction be absent;
   (c) the testicle is normal in position.
5. Properitoneal herniae will be found and dealt with more readily if exploration of the inside of the sac and peritoneal cavity in relation to the inguino-femoral region is carried out as a routine at every inguinal or femoral herniorrhaphy. A routine anatomical display of the inguinal canal will favour their discovery.
6. When dealing with a strangulated interparietal hernia a combined abdomino-inguinal approach will more readily expose the site of obstruction.

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REPAIR OF SLIDING INGUINAL HERNIA

By Kenneth R. Cox

Royal Melbourne Hospital

SLIDING hernia is Weir's translation of the French term *hernie par glissement* or *hernie en glissade*. Other terms have been acystic hernia, *quasi sclrucciolando* (almost sliding), and sacless hernia. Essentially the peritoneum which has migrated to form the hernial sac includes some organ, normally retroperitoneal, on its posterior aspect. The common organs are colon, caecum and bladder, but appendix, broad ligament structures and ileum have been observed.

Operative repair of these hernias from below has been designed to dispose of the troublesome content of the sac wall so that hernial repair can proceed. This paper indicates the dangers and difficulties of that method, and emphasizes the transperitoneal approach of La Roque as being an easy procedure with restoration of normal anatomy. Six personal cases are used for illustration.

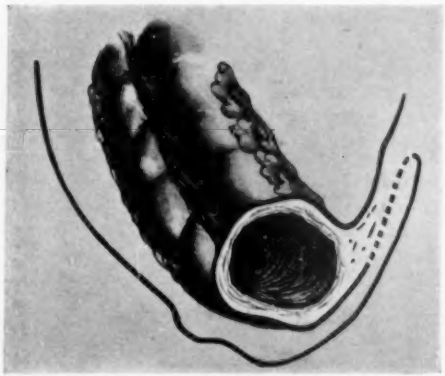

FIG. I

Incidence

The frequency of this condition is variously quoted from 1 to 3 per cent. of all hernias.

Ninety per cent. of cases occur in the male.

Ninety-five per cent. are inguinal and 5 per cent. femoral.

The right side is affected more frequently than the left in the ratio of 2 to 1.

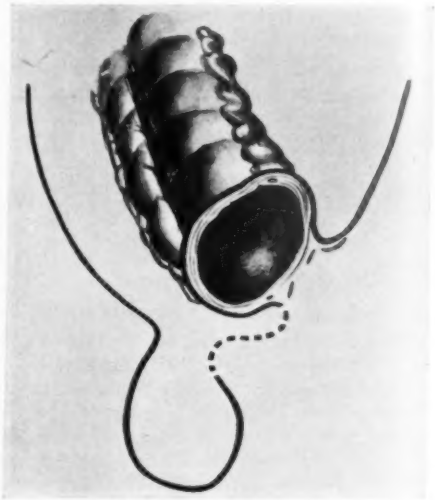

FIG. II

Surgical Anatomy

The changes in sliding hernia are most easily illustrated in para-sagittal plane diagrams on the left side. The peritoneum which migrates to form the posterior wall of the hernial sac is acquired from the inferior or lateral leaf of pelvic mesocolon (Fig. I). The sigmoid colon now becomes partly retroperitoneal (Fig. II) and further peritoneal movement includes that on the front of the colon. The colon then moves outside the peritoneal cavity through the internal ring of the inguinal canal (Fig. III).

Part of the anterior wall of the hernial sac has been formed from the lower leaf of pelvic mesocolon, and this fact is confirmed when

the hernia is reduced transperitoneally. Now it is seen that the opening made in the anterior wall of the sac lies as a split in the lower leaf of mesocolon. Further, this observation refutes the rationalization that iliac and not sigmoid colon moves into the sac wall.

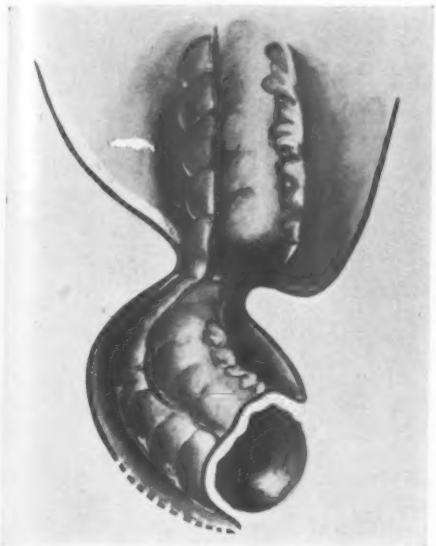

FIG. III

With other organs the same mechanism of peritoneal movement occurs. The layers of the broad ligament separate in the same way as do those of pelvic mesocolon with the peritoneum of the inferior layer forming the anterior sac wall, then tube and ovary followed by the superior layer.

On the right side, caecum is progressively denuded on its posterior aspect as its peritoneum is dragged down into the sac, and in one case recorded here the posterior leaf of small bowel mesentery at ileocaecal junction had moved into the sac so that ileum, caecum and appendix presented superior to the hernial sac wall.

HISTORICAL REVIEW

The earliest reference to sliding hernia is by Percivall Pott in his *Treatise on Ruptures:*

"The intestine said to be most frequently found in a scrotal hernia is the ileum, though it is also allowed that the caecum and part of the colon have been met with.

This is one of the many maxims which writer received from writer, and inattentive readers all believe.

That a portion of the ileum does often descend in a hernial sac is beyond all doubt; but that the descent, or more properly protrusion, of a part of the caecum and colon is rare, is not true, for it happens very frequently. Perhaps it would not bear to be established as a general rule; but from what has fallen within my observation, in frequently performing the operation for a strangulated rupture, it has appeared to me, that the greater number of those in whom it has become necessary (all attempts to reduce the parts by hand having proved fruitless), have consisted of the caecum with its appendicula, and a portion of the colon.

. . . . ruptures are sometimes rendered difficult to be reduced, by that portion of the intestinal canal which is called the caecum, or the beginning of the colon, being contained in the hernial sac. Of which fact I am as much convinced as the nature of such kind of things will permit; that is, by observations made both on the living and the dead."

Pott was also aware of the dangers of operation on these patients:

"I am not unaware that most of these are capable of being cured by the operation for the bubonocele, as it is called; but, as I should never think of proposing it in any case in which there are not symptoms that threaten the life of the patient, so I have not mentioned it in this place as a means of cure. I also am not unapprised what influence a successful operation or two of this sort has had on the unknowing; but I also know, that such accidental successes have emboldened the same operators to commit more than one or two murders in similar cases; and that, from the prevalence of fashion, some of these rupture-doctors have been largely rewarded, when they ought to have been hanged."

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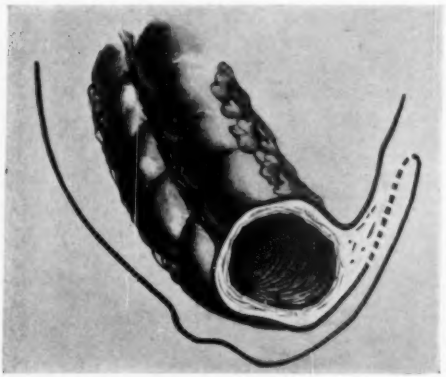

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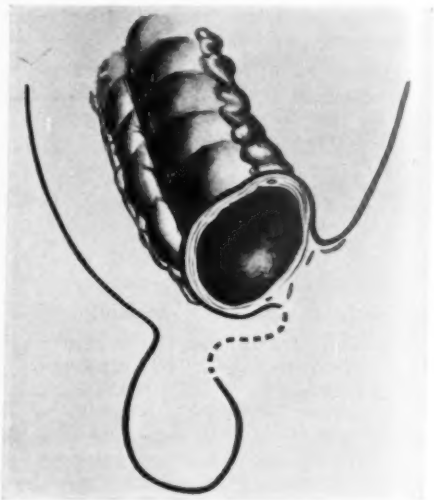

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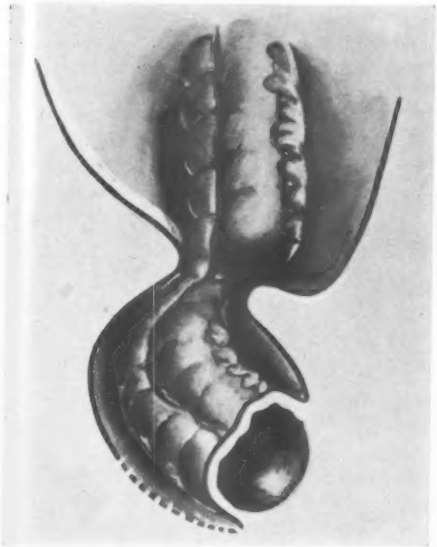

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Hesselbach, Liston, Astley Cooper and Scarpa all described the hernia in the early 19th century, with a sound idea of the mechanism.

Modern attempts at reconstruction of the mesocolon were begun by R. F. Weir (1900) by incising the sac parallel to the edge of bowel and suturing these flaps behind the mobilized bowel. The bowel was then reduced through the internal ring (but only as far as the internal ring). The sac was then reconstructed and closed.

This method was practised with modifications by Hotchkiss, Kirschner, Walton, Bevan, King, Burton and Blottner, Zimmerman and Laufman, and Iason. Criley criticized the method for the possible constriction of blood supply to the bowel.

On the right side, David incised the upper sac longitudinally on each side of the caecum, returned caecum to the abdomen, and sutured the anterior flap behind it.

These repairs from below are unsatisfactory or dangerous because:

(i) Possible injury to bowel wall in freeing the posterior sac from the cord structures.

(ii) Possible injury to bowel vessels in dissecting behind the bowel. This is inconvenient, difficult and unnecessary. King has observed localized gangrene of the gut after this operation.

(iii) Herniotomy is made

(a) difficult, for the colon keeps slipping down from above;

(b) unsatisfactory, for either it is not high (when the colon is merely pushed back and whatever peritoneum can be grasped is tacked together near the internal ring); or it can be associated with a peritoneal split in the flap repairs unless dissection is carried well above the internal ring, and this can be a difficult procedure from below;

(c) dangerous to bowel wall and vessels again in the ill-exposed region beyond the internal ring.

(iv) Bowel and its blood supply are now fixed to anterior abdominal wall. There are dangers to bowel in such fixation, and recurrences are made very difficult to deal with.

(v) No attempt is made at complete reduction in terms of the normal anatomy, or to attempt any manoeuvre which prevents further sliding. That is, if the hernia occurs because of the pull of sac from below and the push from above, then only the former force is dealt with, and that often incompletely.

(vi) Recurrence rate is between 10 (Nelson) and 50 per cent. (Bisgard).

Accordingly, these hernias were then attached from above, first by Fiaschi of Sydney Hospital (1907), who used a muscle-splitting incision for colopexy to supplement the repair from below. Sigmoid colon was sutured to the parietes after denuding an area of iliac fossa of peritoneum.

Paul La Roque in 1919 advocated a muscle-splitting incision above the internal inguinal ring for all inguinal and femoral hernias, and in 1932 illustrated in detail its application to the reduction and repair of sliding hernia. Alexis Moschowitz had described this method in 1925.

This technique has been supported and used by Williams, Barnes, Watson, Roscoe Graham, Mackid, Brown, Jacobson and Smith; yet standard textbooks of surgery have shown little appreciation of the method.

DIAGNOSIS

The nature of the hernia may be suspected but is rarely diagnosed pre-operatively. The clinical features are a large bulky hernia with wide inguinal rings. Control by truss has been poor for some time, and frequently the truss causes pain. The hernia is commonly irreducible wholly or in part, and with such wide rings this indicates a sliding hernia or

intrasaccular adhesions. Barium enema has been used to define large bowel in the sac, but does not exclude sigmoid colon as a content rather than a component of sac wall.

At operation there is much fat around the hernial sac which is thick and vascular. When the sac is open the presence of large bowel whose peritoneum merges with the wall is readily seen.

The value of diagnosis is in avoiding attempts to dissect colon free from peritoneum under the impression that adhesions are preventing reduction of the contents.

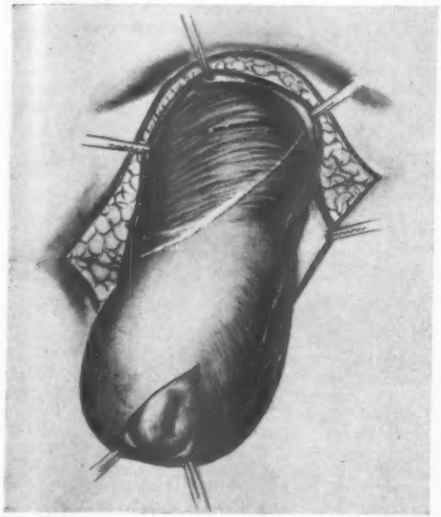

FIG. IV

METHOD OF REPAIR

The sac is exposed through the usual inguinal incision 2 cm. above, and parallel to Poupart's ligament. External oblique aponeurosis is cut laterally from the external ring. The sac is opened and the diagnosis made. The anterior aspect of sac is cleaned from the cord structures.

The upper margin of external oblique aponeurosis is now retracted upwards exposing internal oblique muscle and the ilio-hypogastric nerve (Fig. IV). Internal oblique and transversus muscles are split in the line of their fibres about 2 cm. above their lower borders, avoiding the nerve. The peritoneum is opened.

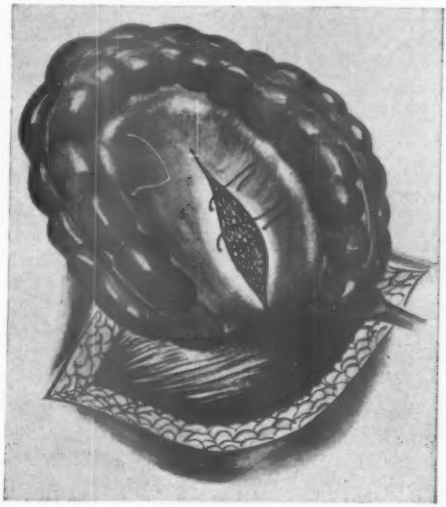

FIG. V

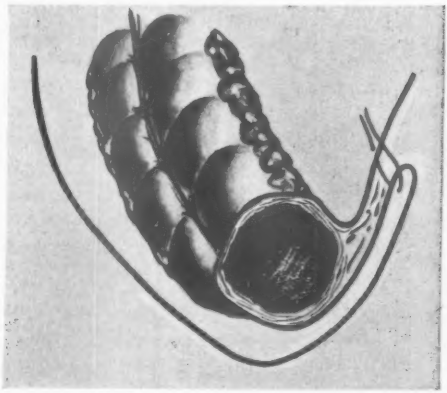

FIG. VI

The sigmoid colon is now seen passing through the internal ring and is drawn upwards into the wound. The hole in the sac is seen as a slit in the lower leaf of sigmoid mesocolon (Fig. V). If the sigmoid colon has been well down the posterior wall of the sac, then the sac is seen to be reduced completely. If not, traction easily produces the

last of the peritoneum which can be cut off and sutured within the peritoneal cavity.

Thus herniotomy, the difficult, dangerous and unsatisfactory part of the operation from below, has been achieved completely, as high as is possible, and any oversewn stump of peritoneum can be fixed to fascia transversalis away from the internal ring if there is a preference for this manoeuvre.

Some attempt is made to reduce the tendency for sliding by suturing together the upper and lower leaves of sigmoid mesocolon (Fig. VI). This is best achieved at the time of suture of the split in the lower leaf (Fig. V), for the vessels in the excessively fatty mesocolon in these patients can be more readily seen then.

The repair of the hernia is now proceeded with, by exposure and repair of the internal ring and the medial split in fascia transversalis. Repair of the posterior wall of the inguinal canal is facilitated by a hand behind the canal through the upper wound.

After an appropriate repair both wounds are closed.

ADVANTAGES OF TRANSPERITONEAL APPROACH

1. Reduction of the colon is facilitated.
2. The entire sac and any excess of peritoneum are removed from the inguinal canal.
3. Pelvic mesocolon is restored in its anatomical position, and the separated leaves of mesocolon rejoined, reducing the likelihood to further sliding.
4. Any unusual conditions of the sac or its contents are more easily recognized and repaired.
5. Repair of the posterior wall of inguinal canal is assisted by a hand behind it.
6. The colon can be fixed to the parietes if desired.
7. The stump of sac, if it exists, can be fixed away from the internal ring if desired.

CASE REPORTS

Case 1

Mr. S.W., aged 55, was admitted as an emergency case on 20th March, 1955, with a strangulated left inguinal hernia. A lump had appeared in the left groin thirty-six hours previously, associated with colic, constipation and some distension. There was no vomiting. The hernia was tense, tender and irreducible with no impulse on coughing.

At operation the sac was exposed and opened through the external oblique aponeurosis, demonstrating the colon. The obstruction at the external ring was relieved and bowel viability assured.

The incision was extended upwards and laterally, external oblique aponeurosis retracted upwards and a muscle-splitting incision made through internal oblique and transversus muscle 5 cm. above the lower border of internal oblique muscle. The bowel was delivered into this wound, and identified as pelvic colon. The hole in pelvic mesocolon was sutured, and the two leaves of mesocolon sutured together with silk.

Redundant hernial sac was delivered into the peritoneal cavity, twisted and ligated.

The posterior wall of inguinal canal was restored by a repair of fascia transversalis with silk.

Pyrexia was present for some days post-operatively for which no cause was detected.

The patient was discharged nine days after operation.

Case 2

Mr. W.R., aged 57, was admitted on 18th April, 1955, for the repair of bilateral inguinal herniae present for over fifteen years and easily reducible. Ten weeks previously he had presented with a strangulated epigastric hernia which was repaired.

At operation right indirect and direct hernial sacs were present, and repaired. On the left side colon was seen on opening the sac. The skin incision was extended upwards and laterally and the peritoneal cavity opened through a transverse muscle-splitting incision 4 cm. above the inguinal canal. The colon was retracted from the inguinal canal and identified as sigmoid colon. The opening into the sac appeared now as a vertical split in the mesocolon and was repaired. The two layers of mesocolon were sutured together as close to the base of mesocolon as possible. No peritoneal sac remained.

The split in fascia transversalis was repaired up to and including the internal ring, and the layers closed at both sites.

The post-operative course was interrupted by a bout of bronchitis, and the patient was discharged eight days after operation.

Case 3

Mr. W.D., aged 29, was admitted on 31st May, 1955, for the repair of a right inguinal hernia present for three months and easily reducible.

At operation the sac contained the appendix and had caecum and small bowel mesentery as components of the sac wall. Ileum had slid to the region of the internal ring.

Skin and external oblique aponeurosis were retracted upwards and a muscle-splitting incision made through internal oblique and transversus muscles, through which the layers of small bowel mesentery were sutured together. This reduction drew the sac up entirely.

The internal ring was repaired with silk.

After an uneventful convalescence the patient was discharged on the thirteenth post-operative day.

Case 4

Mr. A.M., aged 86, was admitted on 27th May, 1955, with a strangulated left inguinal hernia. The lump had been present for eight years and was controlled by a truss until two days before admission when it was irreducible. Colic and constipation followed, and on admission the hernia was tense, tender and irreducible with no impulse on coughing.

At operation pelvic colon was seen to be a part of the wall, and was reduced through a parallel incision through, and 5 cm. above the lower border of internal oblique. The opening in the sac was then observed to be a vertical split in the lower leaf of mesocolon. These layers were sutured together.

After reduction no sac remained. The posterior wall of the inguinal ring was reconstituted by a repair of the fascia transversalis up to the internal ring using silk.

He was discharged on the sixth post-operative day after an uneventful convalescence.

Case 5

Mr. J.J., aged 56, was admitted on 13th September, 1955, with a right inguinal hernia of eight years standing.

At operation the caecum formed part of the sac wall. The appendix was free as a content of the sac.

Reduction of the contents was made via an incision through the internal oblique and transversus muscles. The opening in the sac was seen to lie behind the caecum. This peritoneum was repaired and sutured back to the caecum.

No hernial sac remained after restoration of the peritoneum. The fascia transversalis was repaired, and tested from above. The upper incision was then closed.

The patient was discharged twelve days after operation. His convalescence was marred by a bout of severe bronchitis.

Case 6

Mr. S.S., aged 64, was admitted to a medical ward on 19th May, 1955, with aplastic anaemia and a left inguinal hernia present for many years and irreducible for three days. Twenty-four hours after admission spasms of abdominal pain commenced associated with constipation. The hernia was tense, tender and irreducible with no impulse on coughing.

At operation a large hernial sac presented and contained colon as a wall component.

Internal oblique and transversus muscles were divided in the line of their fibres 5 cm. above the inguinal canal and peritoneum opened. The sac and pelvic colon were delivered through the internal inguinal ring and out through the upper opening. The opening in the sac was then seen as a vertical cut in the inferior leaf of pelvic mesocolon. This was repaired and the two leaves of mesocolon were sutured together. The sac had been completely reduced and no redundant sac was apparent.

The posterior wall of inguinal canal was repaired by suture of fascia transversalis. The spermatic cord was still thick and was dissected for reduction of its contents to enable tighter closure at the internal ring. After dissecting fat away a second indirect hernial sac was apparent at a deeper layer and extending into the scrotum. This sac was dissected and invaginated through the internal ring where it was ligated and cut off.

Three days post-operatively the patient suddenly became shocked and dyspnoeic, and complained of a tight pain in the epigastrium and some nausea. The electrocardiograph showed a recent posterior myocardial infarction. The patient died three hours later.

Autopsy showed myocardial infarction and acute membranous colitis of the left colon.

SUMMARY

1. The mechanism of sliding hernia is described, and the abnormal anatomy illustrated.
2. Brief mention is made of the history of operative repairs used.
3. A method of repair is described and its advantages noted.
4. Six cases are reported.

ACKNOWLEDGEMENTS

I wish to thank the staff of the Royal Melbourne Hospital for permission to publish these cases, especially Mr. John Turner who stimulated and encouraged my interest in this problem. Professor Ewing and Mr. E. S. R.

Hughes are also to be thanked for their constructive criticism, and Miss S. de Berenger for her careful drawings.

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SUBACUTE NODULAR POLYANGEITIS

By E. S. J. KING

Department of Pathology, University of Melbourne

IN all inflammatory conditions, change of some degree is to be found in all the tissues in the vicinity of the main focus; thus, alterations in the walls of the vessels may be observed frequently and, possibly for this reason such changes are either overlooked or regarded as secondary to those occurring in the intervascular tissues, even in some cases in which, in fact, the principal and primary changes are in the vessels themselves. There is a group of conditions however, which has become well recognized in the last two decades. In these the maximal change is in the wall of vessels, particularly of the arteries.

The condition of polyarteritis nodosa was described (as peri-arteritis) in the last century but was not generally recognized, with any frequency, until relatively recently. It does not seem likely that this condition has become much more common in the last few years, but rather that its presence was not previously appreciated adequately. The other particularly striking condition is temporal arteritis which is a characteristic lesion occurring in and apparently localized to the temporal artery, usually of older patients. It shows not only a characteristic clinical syndrome but also very distinct and definite pathological features.

In the first group the clinical features are now well recognized, where the lesions are accessible, as the development of nodules and on histological examination characteristic changes of acute or subacute inflammation are to be found. When this occurs in visceral vessels the condition is usually fatal but a subcutaneous form of less serious prognosis is well known. This affects the small arteries and arterioles.

Some years ago the writer observed a case in which there were changes not only in the small arterioles but also in the capillaries and veins, and the features were different in some respects from those seen in other cases of primary inflammatory arteriolar disease. This condition appears to be a rare one and since our knowledge is often advanced by the gradual accumulation of cases which are only rarely seen, this case is now recorded.

CASE HISTORY

V.I., male aged 28, was seen in 1931. He had had no significant illnesses although he was liable to develop hay fever during the spring months.

For the previous nine months, he had observed lumps which developed in various parts of the body. Careful interrogation of the patient and examination of some of these, showed that they occurred mainly in the limbs but to some extent on the trunk. Some of them appeared to be definitely subcutaneous, but others were subfascial, apparently in muscles.

The nodules appeared fairly suddenly and gradually became larger until they reached an average size of about one inch in diameter and then, over a period of several weeks, they subsided. The total period over which any lump was observable ranged from six to ten weeks. After complete subsidence no thickening or other evidence of the nodule remained.

He presented for examination specially for a nodule in the left submaxillary region. This had been present for about four weeks, was about one inch in diameter and was slightly tender to the touch. Its nature was uncertain but it was regarded as an enlarged lymph node in the submaxillary region. Evidence was sought for some primary focus but none was found. A possible relation to the other nodules that he had was not then seriously considered because of the site of the nodule.

He was observed at intervals for the next six weeks during which the nodule fluctuated slightly in size but did not become significantly larger. The patient considered that it was rather different from other nodules especially in that it was more persistent and as a result of his importunities it was decided that the nodule should be removed.

At operation an incision parallel with the jaw was made just below the margin of the mandible and the nodule was found in the submaxillary triangle. It

was reasonably well defined although it was not sharply delimited from the surrounding tissues. It was removed relatively easily without the removal of the submaxillary gland.

When removed, the nodule was well defined but did not have a definite capsule and on cross section was somewhat fibrous but showed a whorled appearance.

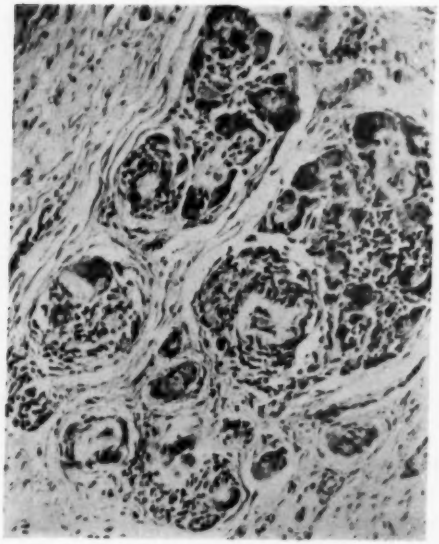

FIG. I. Photomicrograph of a section from the submaxillary nodule showing cellular collections including foreign body giant cells, spindle cells and small round cells. These collections have, at first sight, a definite folliculoid arrangement. (x 140)

Histological examination

This showed that the tissue was composed of numerous collections of what appeared at first to be folliculoid bodies containing foreign body giant cells with surrounding endothelial cells and fibroblasts with a few wandering cells, principally of the small rouund cell type (Fig. I). More careful examination, however, showed that these bodies were in fact, in most places, actually vessels. They varied very much in form. Some of them showed an actual lumen but in most of them the lumen had disappeared. In some places the wall was hyaline in character (Fig. II) and in others it was very cellular, many of the cells being giant cells (Fig. III).

Some of the vessels were relatively large and definitely small arteries or large arterioles, but many of them were of much smaller size and some appeared to be, as far as could be determined amongst the inflammatory cells, capillary in dimension. Amongst the cellular tissue, both in the vessel walls and outside them dilated capillaries containing red blood corpuscles were found (Figs. II and VII). In areas where most of the pre-existing arterioles had been occluded, such capillaries presumably constituted the nutritive supply. Although most of the affected vessels appear to have been relatively thick-walled, others were thin-walled and it seems clear that they had been veins rather than arteries (Fig. IV).

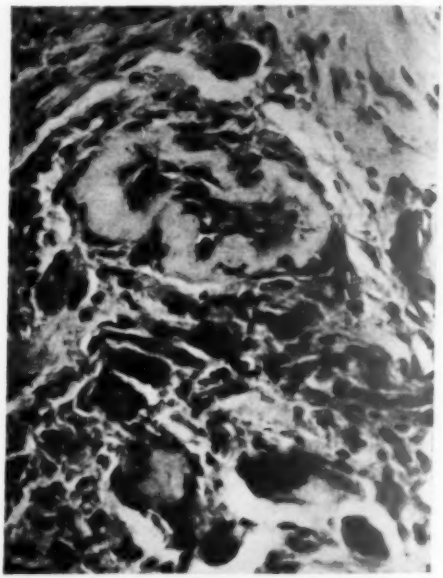

FIG. II. Higher power view of one of the follicle-like collections showing a definite occluded vessel with a hyalinized wall. The lumen is replaced by numerous spindle cells and foreign body giant cells are numerous in the immediate neighbourhood. A few capillaries containing red corpuscles (possibly newly formed) are also present. (x 560)

The condition thus was a peculiar inflammatory condition arising in the walls of vessels of both arterial and venous (and even capillary) type. The condition was clearly

from the histological point of view, chronic in form and did not show any characteristics of any specific form of chronic inflammation. Special stains of various kinds failed to show any special features and organisms could not be demonstrated.

FIG. III. Photomicrograph showing typical cellular accumulation and giant cell formation in and around a collection of small vessels. These are indicated by the remnants of hyalinized walls (x 280)

Subsequent course

The patient continued to develop nodules of the kind that he had had previously for another twelve months, after which they ceased to occur, that is to say, he had these episodes of development of nodules for nearly two years when they ceased relatively abruptly and he has not had any more since.

In the subsequent years he has shown a considerable presumptive sensitiveness to some foreign material in the form of either coryza or, in some years, asthma, particularly in the spring. Until recently he has been relatively well except for the development of a skin tumour of the face of the rodent ulcer type. This has been treated satisfactorily.

In the last few years he has developed a blepharitis and conjunctivitis which appears to have been "allergic," being worse in spring and autumn, and apparently related, in their time of occurrence, to his previous coryza and asthma; but otherwise he has been fairly well. He has not, in the last twenty-five years, shown any further lesions similar to those seen when he presented first.

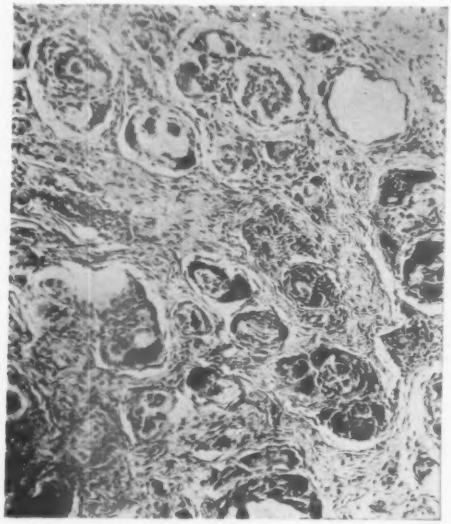

FIG. IV. Photomicrograph showing collections of folliculoid bodies which are here obviously related to numerous vessels of various sizes. At the top right corner a vein is present and near this another showing spindle cells growing into the lumen. Various stages in cellularity and thickening of the wall of vessels are to be seen in various parts. (x 140)

DISCUSSION

In various conditions in which the arteries or veins are primarily or mainly involved the changes range from those of acute inflammation with rapid accumulation of wandering cells to the most chronic forms of slow fibrosis. In the two conditions mentioned previously there is a similar considerable difference between the type of lesion found. In polyarteritis it is usually a wandering cell accumulation with some proliferation of local cells; in temporal arteritis there is largely a cellular proliferation with the formation of giant cells in the wall of the arteries. In this case the arteries are of considerable size. There is thus a wide range in the appearances to be found in arterial disease.

In almost all of the cases that have been described in the literature the changes are found in the arteries or arterioles. When one examines particularly the changes in vessels in various inflammatory conditions — and, from many points of view, an interesting one is fat necrosis of the breast — it is found that not only arteries but also veins and capillaries are affected. In the present case there is no question, from the examination of the material, that all forms of vessels are affected almost in equal degree and indeed particularly smaller vessels are involved. Groups of these are well seen in some of the photomicrographs (Fig. V). It is for this reason that it is felt that it is quite inappropriate to regard the condition as an arteritis and for that reason the term angeitis has been suggested.

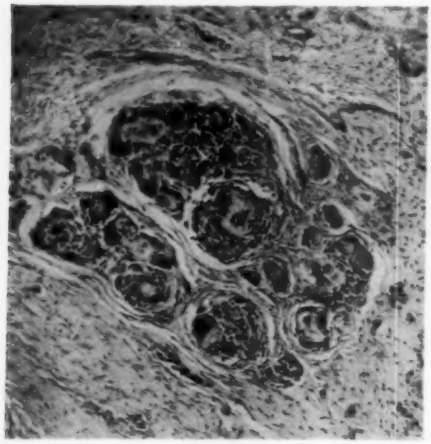

FIG. V. Low power photomicrograph showing the characteristic grouping of the cellular masses. The relation to small vessels of various kinds is here well shown. The smaller ones may be compared with the vessels of slightly larger than capillary size in the peripheral fibrous tissue. (x 100)

As far as aetiology is concerned the exciting factors in the development of arterial changes are not known although it has been suggested that some allergic phenomenon is responsible for these as it appears to be for many of the diseases of the "collagen" group. However this may be for polyarteritis generally, it seems quite clear in the present case that there is a close relation to some kind of hypersensitive state but the precise relation of this to the arterial changes observed is not clear.

As far as the histological changes are concerned, it is quite clear that all parts of the vessel are involved. The endothelium shows considerable proliferation and there is definite occlusion of the vessels by collections of endothelial cells (Fig. VI). In some cases these are particularly clearly shown because they do not completely fill the vessel but project into it. In other cases, however, they completely occlude the vessel.

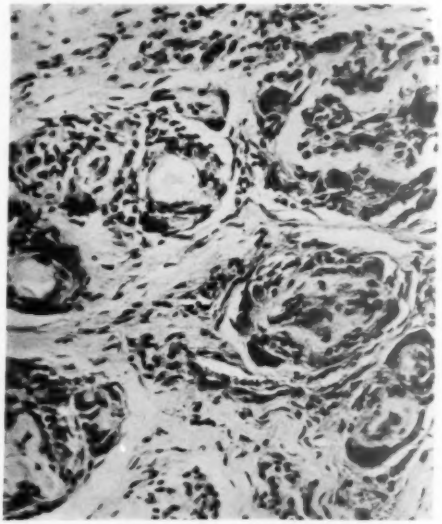

FIG. VI. Photomicrograph showing cellular groups in relation to vessels of various sizes. Some are occluded by spindle cells and giant cells and others show giant cells in the adventitia. Most have a well-defined hyaline wall. (x 280)

Involvement of the media is shown in many of them by complete hyalinization (Figs. II and VI), a hyaline band corresponding to the medial zone being a prominent feature. In other cases there is a gross increase in the number of cells in the medial coat. Most of these appear to be of the endothelial or connective tissue type. It is in this region that many of the giant cells are found, although some of them are to be found in the adventitia of the vessels (Figs. III and VII).

The significance of the giant cells is not clear, although they are clearly of the foreign body type. They appear to occur by aggregation of endothelial cells usually in the medial zone though, as mentioned above, also on the periphery of the vessels. In some cases there

are spaces which correspond to the cholesterol spaces seen in other tissues and some cells show a foamy protoplasm (Fig. VIII). Whether these are related to the deposition of some insoluble, probably fatty, material is not certain but the appearances suggest this explanation.

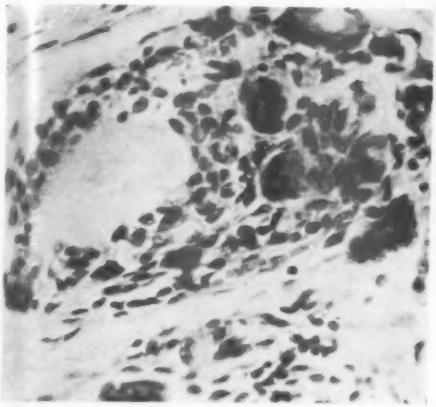

FIG. VII. Photomicrograph of a vessel occluded by hyaline material, the walls very cellular with giant cells and spindle cells. (x 560)

In some of the sections dilated thin-walled vessels are to be found and these appear to be quite definitely venous in character (Fig. IV). The smaller cellular groups are easily compared with small thin-walled vessels at their periphery and their probable original capillary size corroborated (Fig. V).

The nature of the changes in this case are those of non-specific inflammation of unusual type and the aetiology of the condition is obscure, but, as with other diseases, the importance of the recording of cases which are rare is evident, since only by the gradual accumulation of such as these can progress be made. In many other conditions the accumulation of records of such cases has been the necessary precursor of definite advance in the knowledge of the subject.

FIG. VIII. Collections of giant cell tissue round numerous small blood vessels. The protoplasm of some of the cells is foamy. There are some spindle-shaped spaces resembling those seen in cholesterol deposits. Some of these vessels still retain a distinct lumen. (x 320)

SUMMARY

An example of a disseminated nodose form of vascular inflammatory change, characterized by the development of subcutaneous and muscular nodules, is described.

The disease was of limited duration and has not (in a quarter of a century) recurred.

The histological features differed from those of polyarteritis nodosa in that histological changes were found in arteries, veins and capillaries.

The changes also were more chronic in type and in some respects, especially the development of giant cells, resembled those of temporal arteritis.

SURGICAL ANATOMY OF THE ANAL CANAL

By E. S. R. Hughes

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FOR twenty years the surgical anatomy of the anal canal, in the form described by Milligan and Morgan (1934), has been accepted and their brilliant work has been widely acclaimed (Fig. I). More recently descriptions have appeared (Wilde, 1949; Parks, 1954; Goligher, Leacock and Brossy, 1955) which have been at variance with those of the St. Mark's Hospital surgeons and, accordingly, some aspects of the anatomy have been re-investigated (Figs. II and III).

The chief features of Milligan and Morgan's classical descriptions are incorporated in Fig. I.

Internal sphincter

The internal sphincter is a direct continuation of the circular muscle wall of the rectum in to the anal canal. The lower border of the muscle extends to within a quarter of an inch of the anal verge. It is cylindrical in shape, and the well-defined and somewhat thickened lower border is easily felt at the level of the anal intermuscular septum.

External sphincter

This muscle is composed of three parts.

(a) Subcutaneous portion. This is an annular band encircling the lowermost portion of the anal canal. It lies in the same plane as the internal sphincter, from the lower border of which it is separated by an annular sheet of fascia, the anal intermuscular septum. It has no attachments to bone. It can be seen and felt beneath the skin of the anus.

(b) Superficial portion. The superficial portion lies deeper than the subcutaneous, and is elliptical in shape, attached to the coccyx posteriorly and the central portion of the perineum anteriorly.

(c) Deep portion. This is the uppermost portion of the external sphincter. It is intimately related to the levator ani above, and the superficial portion of the external sphincter below.

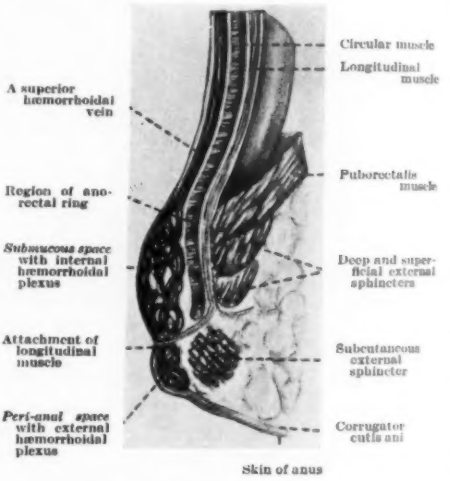


FIG. I. Surgical anatomy of anal canal according to Milligan and Morgan (from the *Lancet*, 1934). [Reproduced with permission.]

Longitudinal muscle

The longitudinal muscle is a continuation of the longitudinal coat of the rectum, reinforced by blending with the fibres of puborectalis. The longitudinal muscle ends by dividing into two main septa; one passes between the lower border of the internal sphincter and the subcutaneous portion of the external sphincter forming the anal intermuscular septum which becomes attached to the skin of the anus near the muco-cutaneous junction, and the other passes outwards to

separate the peri-anal space from the ischio-rectal.

Anal intermuscular septum

At the upper and inner end of the subcutaneous sphincter is a well-marked depression, one-eighth to one-quarter of an inch in width, which is produced by the attachment of the anal intermuscular septum to the mucous membrane at this site. The anal intermuscular septum is the inner of the two main terminal septa of the longitudinal muscle. Above the groove caused by the attachment of the anal intermuscular septum the lower edge of the internal sphincter can be demonstrated if the subcutaneous sphincter be retracted outwards with the finger.

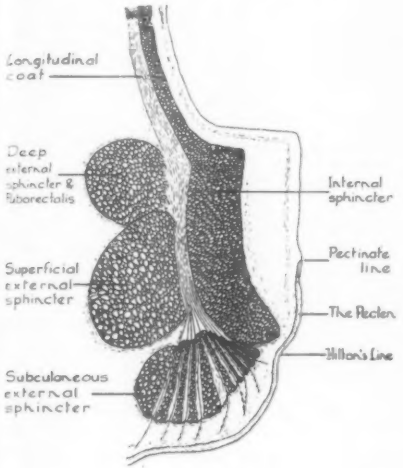


FIG. II. Surgical anatomy of anal canal according to Wilde (from the *British Journal Surgery*, 1949, vol. 36).

[Reproduced with permission.]

Ano-rectal ring

This term is given to the composite fibromuscular ring which is situated at the junction of the anal canal and rectum; it is composed of the upper part of the internal sphincter, the longitudinal muscle, the puborectalis (portion of the levator ani muscle) and the deep part of the external sphincter. It is readily palpable when the finger is inserted well into the anal canal.

REVISED ANATOMY OF THE ANAL CANAL

The following revision is based on observations made during the performance of ano-rectal operations, supplemented by macroscopic and microscopic studies on excised rectums. The findings confirm those reported after similar investigations by Goligher, Leacock and Brossy (1955) whose work was published after the preparation of this paper was completed (Figs. IV and V).

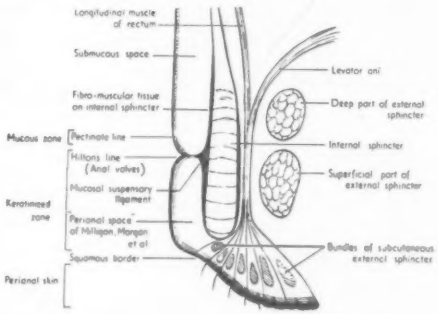


FIG. III. Surgical anatomy of anal canal according to Parks (from *Proceedings of the Royal Society of Medicine*, 1954).

[Reproduced with permission.]

Internal sphincter

The internal sphincter is a direct continuation of the circular coat of the large bowel. It is 30 to 35 mm. in length and 5 mm. in width (Wilde, 1949). The muscle is sharply delineated, bounded on the outer side by a continuation of the longitudinal muscle and on the inner side by the muscularis mucosae, which is also well defined at this level. Extensions of these two longitudinal muscle layers meet around the lower border of the internal sphincter muscle. The pale, compact fibres of the internal sphincter muscle are traversed by thin sheets of tissue passing from the outer longitudinal coat to the inner muscularis mucosae. In many of the surgical dissections of Milligan and Morgan (1934) the lower portion of this well developed internal sphincter muscle has been mistakenly identified as the subcutaneous portion of the external sphincter; in the revised study, the internal sphincter has a more

important role than that ascribed to it by Milligan and Morgan (Fig. VI).

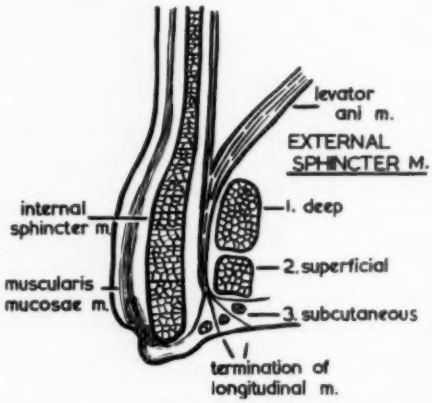


FIG. IV. Revised anatomy of the anal canal.

External sphincter

The description of the deep and superficial portions of the external sphincter muscle has been retained, but the prominent place accorded the subcutaneous portion of the external sphincter has been revised.

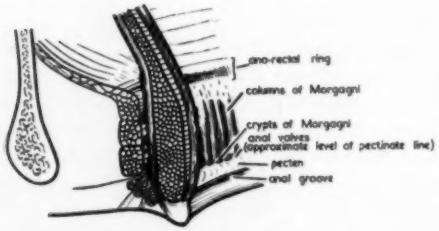


FIG. V. Revised anatomy of the anal canal.

Subcutaneous portion of the external sphincter muscle

This portion of the external sphincter overlaps the internal sphincter (Harris, 1929), but not to such an extent as to form the lower part of the anal canal. The muscle is a relatively thin, red band encircling the anal canal. The subcutaneous sphincter is separated into fasciculi by prolongations of the longitudinal muscle passing towards the skin (Holl, 1896; Wilde, 1949). The subcutaneous portion of the external sphincter is only occasionally identified in the course of haemorrhoidectomy.

Longitudinal muscle

The longitudinal muscle is reinforced by fibres received from the levator ani, but as this conjoint muscle proceeds distally, the muscle fibres are replaced by fibro-elastic tissue. Thin sheets and bundles separate off medially and pierce the internal sphincter muscle to join with the muscularis mucosae.

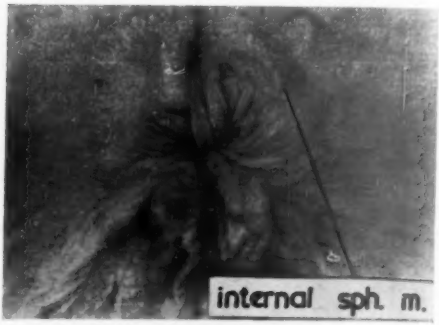


FIG. VI. The outline of the lower edge of the internal sphincter muscle visible under the perianal skin.

The termination of the longitudinal muscle has always been of interest to anatomical investigators. Beraud (1856) observed that the muscle penetrated the sphincter muscle to end in the skin. Since then many independent studies have shown that, before it reaches the skin, the longitudinal muscle splits in to numerous sheets, or bundles (Levy, 1936), which pass through the subcutaneous portion of the external sphincter and divide it into fasciculi (Holl, 1896; Poirier and Charpy, 1901; Wilde, 1949).

One of these terminal sheets of the longitudinal muscle passes between the lower border of the internal sphincter muscle and the subcutaneous portion of the external sphincter muscle and has been termed the anal intermuscular septum; but, apart from its situation, there is nothing to distinguish it from the other terminal sheets of the muscle.

Muscularis mucosae

As the muscularis mucosae proceeds distally, it receives reinforcing strands from the longitudinal muscle coat which pierces the internal sphincter muscle. The muscularis mucosae becomes a well defined structure and reaches maximum development in the region of the crypts of Morgagni and continues in this way to the lower border of the internal sphincter. At this level many of the fibres are attached to the epithelial layers, and appear responsible for the groove, attributed by Milligan and Morgan (1934) to the anal intermuscular septum. Some fibres continue distally, immediately under the skin of the anus to form the corrugator cutis ani muscle. The more laterally placed fibres mingle around the lower border of the internal sphincter with the inner septa of the longitudinal muscle.

Corrugator cutis ani muscle

The term corrugator cutis ani muscle is given to a thin layer of involuntary muscle extending radially from the anus and situated just deep to the skin. Milligan and Morgan regarded these fibres as derived from the longitudinal muscle layer, but almost certainly they are derived from the muscularis mucosae.

Anal intermuscular septum

The term was used by Milligan and Morgan to define a sheet of tissue derived from the longitudinal muscle and which was described by them as separating the internal sphincter from the subcutaneous component of the external sphincter. They pointed out that the anal intermuscular septum was attached in a narrow, sometimes broad, line to the skin of the anus in the region of the mucocutaneous junction. This attachment causes a groove on the mucosal surface and one which is readily identifiable. As has been pointed out above, the anal intermuscular septum of Milligan and Morgan is ill-defined and but one of several septa or bundles representing the termination of the longitudinal muscle. The groove on the mucosal surface attributed to the attachment of the longitudinal muscle seems to be caused by the muscularis

FIG. VII. The anal groove separating the internal from the external haemorrhoid.

This muscle barely receives recognition from Milligan and Morgan in their writings. Yet Harris (1929) demonstrated clearly that the muscularis mucosae increases in volume as the outer longitudinal muscle decreases. Kohlrausch (1854) was so impressed by the size of the muscle that he gave it a special name in this region, the sustentator tunicae mucosae; Fine and Lawes (1940), in a special study of this muscle also called attention to the development of the muscle and suggested the name, muscularis mucosae ani. Roux (1881, Zuckerkandl (1904), Hamperl (1925) and Hill and his associates (1943) have all referred to the specialized appearance of this muscle in the lowermost part of the anal canal.

mucosae which is always well developed in this zone and the inner fibres of which are intimately adherent to the epithelial layer.

This groove is a constant anatomical feature in close relation to the lower border of the internal sphincter; it might be termed the anal groove. This groove separates the internal haemorrhoid from the external (Fig. VII).

above. In some individuals, papillae develop from the tips or faces of the pectineal indentations, and these project in to the lumen of the rectum. They vary in size from short and narrow to relatively long conical structures. Very occasionally two large papillae adjoin one another to form an anal pocket or even be responsible for an anal stricture (Fig. VIII).

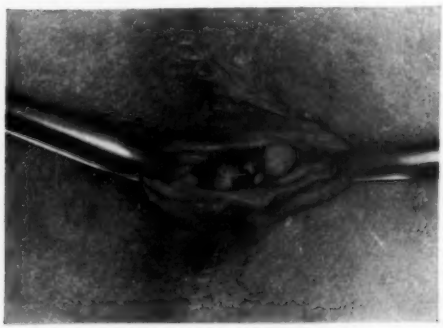


FIG. VIII. Large anal papillae.

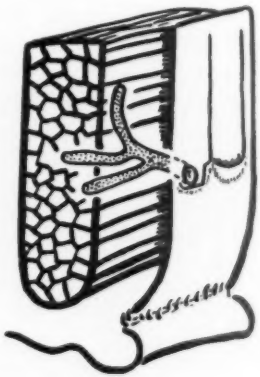


FIG. IX. Anal glands.

Hilton's white line

Hilton drew attention to the line of junction of the internal and external sphincters. He described a white line in the mucosa at this level and believed it to be caused by the transition from the skin to mucous membrane (Hilton, 1863). Ewing (1954) was not able to confirm the presence of a white line; the transition of skin to mucous membrane takes place at a higher level than the lower border of the internal sphincter. The anal groove at the lower border of the internal sphincter is a linear structure, but as it is not distinguished by a white line as described by Hilton, Ewing suggests that the term Hilton's white line be abandoned.

Pectinate line

Stroud (1895) suggested that this term be given to the line along which typical rectal mucosa changes to the stratified epithelium of anal skin. This transition is about the level of the anal valves, but may be a little

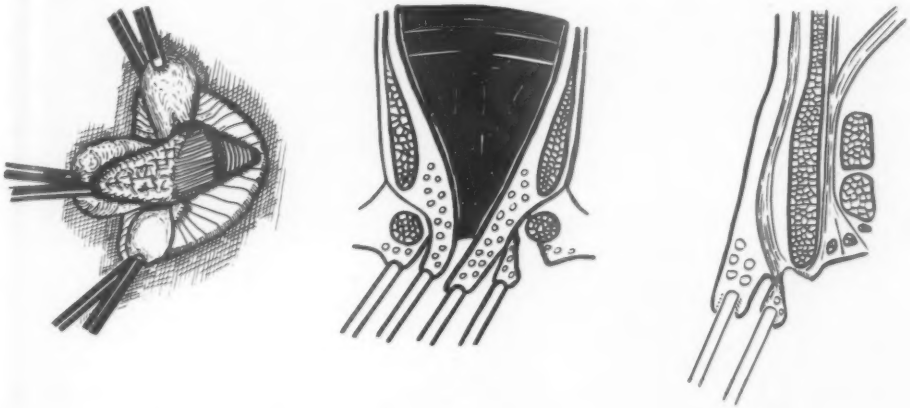
Pecten

Stroud (1896) suggested that the name pecten be given to that narrow area which is bounded by the pectinate line above and Hilton's white line below. As pointed out above, the latter is an indefinite anatomical landmark, and it seems that Stroud is referring particularly to the anal groove (Fig. V) and the immediately adjacent anal canal mucosa. The pecten is said to measure about five to ten millimetres in width, although in places it may be as much as fifteen millimetres. This zone is covered by stratified epithelium and has no sweat glands and it forms the central part of the floor of the rectal ampulla. Harris pointed out that the structure of the submucosa of the pecten and that of the more proximal zone affords a striking contrast. The glandular mucous membrane of the rectum is supported only by lax areolar tissue and a thin regular muscularis mucosae. The pecten zone has a comparatively dense connective tissue matrix

with thick muscular and elastic components, suggesting firm support and anchorage of the mucous membrane to the underlying base.

Anal glands

A special series of glands open into the anal crypts. There are rarely more than six to eight of these glands in the human (Johnson, 1914), but they appear to be constantly present and are most concentrated in the posterior segment of the anal canal. They only arise from the narrow transitional circular zone in which the rectal mucosa changes to the stratified mucosa (Tucker and Hellwig, 1935) (Fig. IX).



(a) (b) (c)

FIG. X. Operation for internal haemorrhoids. The skin cut has been made and circular and longitudinal muscle layers are displayed (a); the Milligan and Morgan conception in cross-section (b); in comparison with the revised anatomical appearance (c).

These glands possess a narrow duct and up to six tubular branches extending into the submucosa. They have often been traced into the internal sphincter (Hill, Shyrock, and Re Bell, 1943; Kratzer and Dockerty, 1947) and occasionally have been seen penetrating the longitudinal muscle (Johnson, 1914; Harris, 1929).

Hermann and Desfosses (1880) described these glands as *glands intestinalis erratiques* and they regarded them as morphological rudiments. Tucker and Hellwig (1935) investigated the glands in the dog, rabbit and pig and concluded that these complex gland organs possessed some definite function, probably sexual, and that they produced odoriferous substances. They suggested that the glands were homologous with the cloacal glands seen in the fowl.

DISCUSSION

This revision of the surgical anatomy of the anal canal does not materially alter the surgeon's approach to ano-rectal problems. Although the teaching of Milligan and Morgan has been shown to be inaccurate in some details, this does not detract in any way from their brilliant work. The major re-orientation entails the subcutaneous portion of the external sphincter, the internal sphincter, the termination of the longitudinal muscle, and the muscularis mucosae.

In the ligature and excision operation for internal haemorrhoids, the internal sphincter and muscularis mucosae muscles have been mistakenly identified as the subcutaneous portion of the external sphincter muscle and the anal intermuscular septum (derived from the longitudinal muscle) respectively (Figs. X and XI).

In the chronic dorsal anal fissure, the same two structures have been confused (Fig. XII).

In the long standing chronic dorsal fissure-in-ano the circular fibres seen in the floor of the ulcer were considered to be those of the subcutaneous external sphincter, whereas they actually belong to the internal sphincter muscle. In some fissures the fibres in the floor of the ulcer are longitudinally placed and these are the fibres of the muscularis mucosae and not the anal intermuscular septum. The anal fissure extends from the pectinate line to the region of the anal groove, and hence it is situated in the pecten portion of the anal canal where the muscularis mucosae is most densely developed and most adherent to the mucosa. Miles (1918) described a pecten band beneath the skin of the anal margin and under the pecten. He likened this band to a rubber umbrella ring beneath the skin of the anus and believed it composed of fibrous tissue and invariably pathological in origin. Miles believed that in the treatment of fissure-in-ano a pectenotomy was necessary.

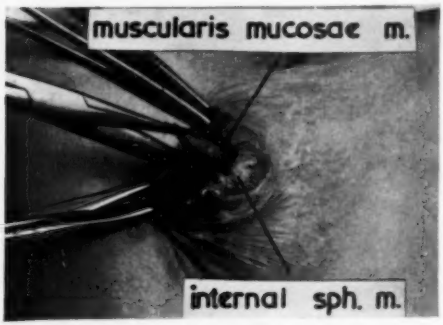


FIG. XI. Operation for internal haemorrhoids: photograph for comparison with the drawings in Fig. X.

The inner boundary of the peri-anal space and the lower border of the submucous space is formed by the muscularis mucosa in the region of the pecten and not by the anal intermuscular septum described by Milligan and Morgan; but apart from this modification the spaces related to the anal canal remain unchanged.

The common type of low anal fistula was described by Milligan and Morgan as passing through the interval which separates the lower border of the internal sphincter from the subcutaneous sphincter; but in actual fact most of these tracks penetrate the internal sphincter to terminate in close relation to the pectinate line. The investigations of Gordon-Watson and Dodd (1935), Tucker and Hellwig (1935), and Kratzer and Dockerty (1947) indicate conclusively that infection of the peculiar anal glands have some role in the development of infections in relation to the anal canal.

FIG. XII. Anal fissure. The muscle in the floor of the fissure is the internal sphincter muscle.

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HEAT AND CORROSION EFFECTS DURING STERILIZATION OF SURGICAL CUTTING INSTRUMENTS

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Summary

EFFECTS of heat and corrosion during sterilization by hot air, steam pressure and boiling in alkaline solutions are investigated. The temper of cutting instruments is unlikely to be seriously affected by exposure to temperatures up to 320°F. Sterilization by steam under pressure may under certain conditions cause heavy corrosion. Sodium carbonate and sodium carbonate-sodium nitrite sterilizing solutions inhibit corrosion. Corrosive attack does not occur preferentially at fine cutting edges.

Introduction

An investigation was made of the influence of a number of commonly-used methods of sterilization on the durability and sharpness of surgical cutting instruments. The methods were studied with respect to (a) effect of exposure to the temperature of sterilization on temper of the blade steel and (b) corrosiveness of the sterilizing medium.

The methods investigated were:*

1. Hot air. Completely effective sterilization requires heating in the hot air oven for one hour at 320°F.
2. Moist heat from saturated steam under pressure. At 270°F and 30 lbs./sq. in., sterilization is almost instantaneous. Lower temperatures and pressures require some time, e.g., 250°F and 15 lbs./sq. in. requires one minute, and 240°F and 10 lbs./sq. in., five minutes.
3. Boiling in aqueous solutions. Boiling water alone will not sterilize. Boiling for five to ten minutes in aqueous solutions containing 2 per cent. sodium carbonate, or 0.1 per cent. sodium hydroxide or a mixture of approximately 0.2 per cent. sodium carbonate and 0.1 per cent. sodium nitrite is considered satisfactory.

*Data relating to sterilizing temperatures and times were obtained from "Handbook of Sterilizing Procedures" (Anon., 1953) and from Foster (1949).

Opinion regarding heat and corrosion effects accompanying these sterilizing methods is largely contradictory. On the one hand there is a widespread belief that any application of heat will ruin a steel cutting edge by drawing its temper, while on the other, hot air sterilization at 320°F is common practice. There is little general agreement of the relative corrosiveness of the various methods. The following appears in *Handbook of Sterilizing Procedures* (Anon., 1953): "The majority of cutting instruments can be effectively sterilized by autoclaving or boiling. Some authorities maintain that the point or cutting edge is better preserved by sterilizing in the hot air oven. This is doubtful, except for such fine instruments as irridectomy knives and scissors." Foster (1949) states that the fine cutting edges of ophthalmic surgical instruments are unaffected by boiling in sodium hydroxide solutions but are destroyed within five minutes in boiling sodium carbonate and sodium carbonate-sodium nitrite solutions unless an anti-corrosion oil is added.

Surgical cutting instruments are usually made from plain carbon steel containing approximately 1.3 per cent. carbon, or from stainless steel containing 12-17 per cent. chromium and 0.2-0.9 per cent. carbon. Kayser (1946) states that stainless steel for fine cutting edges should contain not less than 14 per cent. chromium and 0.9 per cent. carbon.

Effect of Heat of Sterilization on Temper

A steel cutting edge which will maintain sharpness requires a combination of properties the most significant of which is hardness. Hardness, to a large extent, reflects the other properties and while it does not give a

complete indication of the state of temper of the steel it is a convenient quantitative measure. It lends itself as a criterion in that it can be measured on very small articles of almost any shape, and the test is non-destructive.

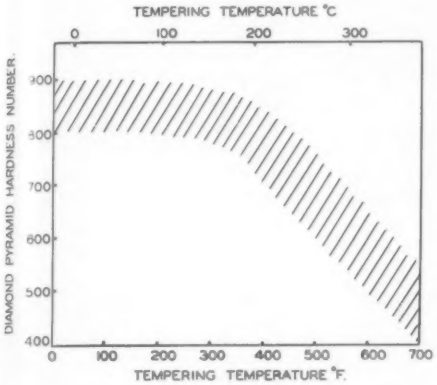

FIG. I. Hardness of high carbon steels after hardening and tempering at 100-700°F. (Figure based on data published in "Metals Handbook," 1948 Edition.)

In its hardest state, steel is unsuitable for cutting edges since the hardening process renders it excessively brittle. Tempering, or heating for a period at a comparatively low temperature is necessary to relieve internal stresses and remove brittleness. Tempering is accompanied by other changes which may be slight or pronounced depending on the temperature, and to a lesser extent the time of heating. Some changes commence at about 70°F, but they are mainly of academic interest until temperatures in the vicinity of 200-300°F are reached. As the temperature is further increased toughness is increased and strength and hardness are reduced. The effect of tempering temperature on the hardness of high carbon steels is shown in Fig. I. The chromium stainless steels would be expected to show a somewhat lower initial hardness, but a higher resistance to softening with increasing tempering temperature. Tempering time is not usually longer than one hour, since the accompanying reactions are substantially completed within this period. In general, the lower the tempering temperature the less significant is the time factor (Fig. II): in the lower ranges substantially the same properties result from one, or one hundred hours heating at any one temperature.

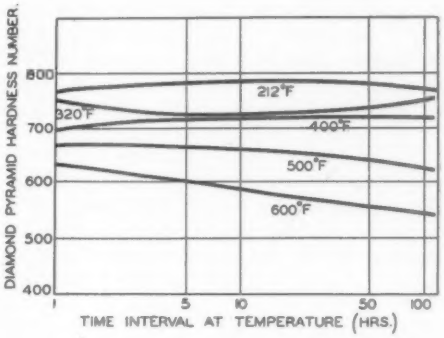

FIG. II. Effect of time interval at tempering temperature on the hardness of a 1.26 per cent. carbon steel. (Figure based on data of Fletcher and Cohen [1944].)

Sterilizing temperatures vary within the range, 212-320° F. As shown in Figs. I and II, within this range hardness does not fall very steeply with increase in temperature and considerable hardness stability is developed at any one temperature. An instrument which had been tempered by the manufacturer at or above 320° F would not be expected to show any appreciable variation in hardness when subjected to sterilizing temperatures. If the tempering temperature were within the 212-320°F range, a change might occur when the instrument was first put into service. The magnitude of the change would depend on the tempering treatment it had received, and the sterilizing temperature, but would probably be small.

A period of reasonable hardness stability of at least 100 hours at sterilizing temperature could be expected even for instruments having the highest hardness. Low sterilizing temperatures and high initial tempering temperatures would greatly increase this period.

Experimental procedure

A number of surgical instruments, representative of those in use at the Alfred Hospital, Melbourne, were tested with respect to

change in hardness after heating within the sterilizing temperature range. The instruments tested were (a) two detachable scalpel blades of English manufacture, brand A, No. 23, and brand B, No. 22; (b) small straight, triangular, suture needle, of unknown origin; (c) hypodermic needle, Continental manufacture, No. 20; (d) suture scissors, English manufacture, two sharp points, overall length 5½ inches.

No attempt was made to establish definitely the composition of the steel used in their manufacture, but each instrument was examined microscopically to confirm that it was in the hardened and tempered condition. Because of the shape and size of the suture and hypodermic needles it was necessary to make micro-hardness readings on polished transverse sections.

The heating tests were performed in an electrically heated circulating air oven with automatic thermocouple control, and in an oil bath.

Results of tests

Changes in hardness were measured after holding the instruments, or portions cut from them, at the upper limit of the sterilizing temperature range (320°F), for periods of up to 11 hours. Only slight variations in

TABLE 1

EFFECT OF STERILIZING TEMPERATURES ON HARDNESS OF CUTTING INSTRUMENTS

	OVEN TEMP. °F	DIAMOND PYRAMID HARDNESS NUMBER					
		Original	After Period at Temperature				
			1 hr.	2 hr.	4 hr.	6 hr.	11 hr.
Scalpel Brand A No. 23	320	803	803	—	—	797	813
Scalpel Brand B No. 22	320	824	820	—	—	813	807
Suture Needle	320	596	—	—	—	595	—
Hypodermic Needle	320	447	—	—	—	439	—
Suture Scissors, first blade	320	736	—	—	672	—	670
*Suture Scissors, second blade, near point	300	722	690	685	684	—	—
Suture Scissors, second blade, near handle	275	716	697	705	701	702	—

*Hardness readings made on polished microsection.

Hardness measurements were made with a Vickers hardness machine and a Tukon microhardness machine, in both cases using the Diamond Pyramid Hardness (D.P.H.) scale, which is based on the size of the impression formed by a pyramidal diamond forced into the surface of the test piece. The scale varies directly with hardness; high hardness is indicated by a high D.P.H. value, and *vice versa*. Hardness tests on the scalpels and the scissors were performed with the Vickers machine; the diamond impressions were, with one exception, made on the flat sides of the blades without prior preparation of the surface. hardness were produced in the scalpels and needles, but the hardness of the blade of the suture scissors showed an appreciable drop. Portions of the second blade of the scissors were tested at 300°F and 275°F, and smaller drops in hardness occurred. The results of the tests are shown in Table 1. Each hardness figure in the table represents the average of not less than three separate determinations.

The No. 23 scalpel was used in a further test to determine the effect of repeated heating to sterilizing temperature, followed by air cooling. The scalpel was immersed in an oil bath, held at 320°F, for approximately 3

minutes and allowed to cool in air to room temperature. This was repeated 20 times during a period of 2 hours. Hardness before and after this treatment were D.P.H. No. 813 and D.P.H. No. 808 respectively.

Discussion of results

The changes in the hardness of the scalpels were slight and unlikely to affect the serviceability of the instruments. A D.P.H. hardness No. of 800 is an average figure for scalpels; D.P.H. hardness Nos. 730-790 have been quoted for some brands of cataract knives.

The suture and hypodermic needles showed almost no change in hardness.

The suture scissors had apparently been tempered at a very low temperature, probably somewhat lower than 275°F. While the hardness of the blade was appreciably reduced at the higher sterilizing temperatures, it is extremely doubtful whether this would be detectable in service in terms of ability to retain an adequate edge. The results shown in Table 1 show the expected development of a high degree of hardness stability at each temperature level.

The result of the repeated heating and cooling test confirmed the belief that no special effects would accompany repeated sterilizing treatments.

CORROSION DURING STERILIZATION

The chromium stainless steels, while not completely corrosion resistant, are greatly superior to plain carbon steels. As a consequence of their chromium content, the stainless alloys have under certain conditions the ability to form an insoluble non-porous surface film which "passivates" the metal. A high degree of passivation occurs in aerated water, in the atmosphere, in alkaline solutions and in acid solutions of an oxidizing nature. If the state of passivation is destroyed, as in some non-oxidizing acid solutions, the chromium alloys will corrode as readily as plain carbon steel. Corrosion may occur with stainless steels as a result of particles of foreign metal becoming embedded in the surface during manufacture, and this may render an article unusable.

An important factor in determining degree of corrosion resistance is surface finish. In general a highly polished surface will show less attack than one which is rough and abraded. Corrosion will be intensified at internal defects which have been exposed by shearing or grinding, and at edges which have been left in a rough and strained condition. There is no evidence, however, to suggest that edges, even if acutely angled, are in themselves particularly susceptible to corrosion.

Carbon steel instruments are sometimes nickel- or chromium-plated for corrosion protection. This is very effective provided the plating is not unduly porous and remains intact in service.

In the following, corrosion is considered in relation to the heat sterilizing methods. The discussion applies chiefly to the highly corrodible plain carbon steels; it may be accepted that chromium steels of good quality are for all practical purposes immune.

Sterilization by hot air

This method is non-corrosive. A visible oxide film may develop on plain carbon steels after prolonged heating at 320°F, but would not have an injurious effect.

Sterilization by heat from saturated steam under pressure

When cold instruments are placed in an autoclave and steam admitted, water will condense on the instruments and continue to condense until they have been raised to the operating temperature of the steam. During sterilizing, the instruments will be in contact with the condensed water and with the supply steam, and these are the media which must be considered as possible sources of corrosion.

Freshly condensed water is only very slightly corrosive to steel provided that no contact is made with air. Water readily dissolves oxygen from the air and the amount absorbed and the temperature of the water determines the amount of corrosion. Oxygen solubility under normal atmospheric pressure varies inversely with temperature, and at boiling point is practically nil. When oxygen bearing water is freely exposed to the atmosphere, the maximum corrosion rate

occurs at approximately 180°F, but in a closed system such as an autoclave the corrosion rate increases with temperature. The condensed water lying on the instruments will thus be corrosive or non-corrosive according to the conditions of contact with air during sterilizing. If air is not completely removed from the autoclave prior to pressurizing, corrosion will certainly occur and it would also be expected if the rate of expulsion of air were unduly slow.

Water in gaseous form as steam is not seriously corrosive to steel at sterilizing temperatures.

Sterilizing by boiling in aqueous solutions

As mentioned earlier, the corrosiveness of water depends primarily on its temperature and oxygen content. In this investigation Melbourne tap water, containing less than 30 p.p.m. dissolved solids, was used. Carbon steel instruments placed in cold or warm water which is then brought to the boil will be extensively corroded. If immersion of the instruments is delayed until the dissolved oxygen has been eliminated by boiling vigorously for some minutes, corrosion is greatly reduced. Corrosion in boiling water cannot be completely prevented in this way, probably because of contamination by returning condensate.

Corrosion can be largely prevented by the addition of alkalis. In alkaline solutions steel develops a stable oxide film which protects the metal from further attack. In neutral or acid solutions the film forms but breaks down constantly, allowing corrosion to proceed. The amount of alkali needed depends on the purity of the water, temperature and oxygen content, but with reasonably pure water at room temperature exposed to the atmosphere, and not artificially aerated, addition of 0.1 per cent. sodium hydroxide, or 0.5 per cent. anhydrous sodium carbonate would reduce corrosion almost to zero. Prolonged periods at temperatures between room temperature and boiling point might require more alkali, but less would suffice in solutions used at boiling point. In water containing appreciable quantities of dissolved salts, particularly chlorides, the protective effect of the alkali is reduced.

References in the literature to sodium carbonate sterilizing solutions do not always differentiate between the anhydrous or crystalline form. A 2 per cent. solution of the anhydrous salt is approximately 2.7 times stronger than a 2 per cent. solution of the decahydrate (washing soda). This may be of importance if pure water is not used, a higher minimum alkali concentration then being necessary for corrosion inhibition.

Sodium carbonate hydrolyses in boiling solutions to form sodium hydroxide; approximately 10 per cent. of the carbonate converts to hydroxide after six hours boiling, with an accompanying increase in alkalinity, and decrease in corrosiveness.

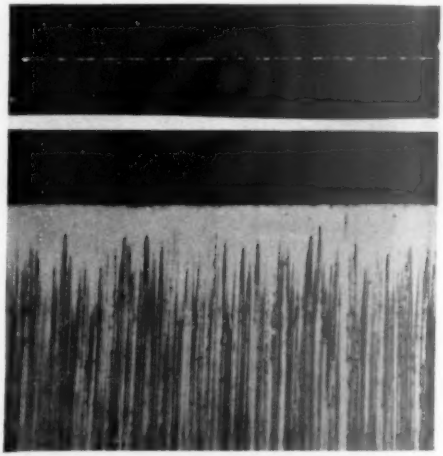

FIG. III. Edge-on and profile views of high quality cutting edge on safety razor blade. (x 375)

Excellent corrosion protection is given by sodium nitrite, which is a common constituent of commercial sterilizing compounds and is added to Zephiran-type disinfectants as anti-rust powder. When present in amounts greater than 40 parts per million, sodium nitrite will completely inhibit corrosion at room temperature. Higher temperatures require an increased concentration. The salt is stable in solution up to 176°F, and breaks down very slowly at higher temperatures. The exact nature of the inhibiting action of

the nitrite is not definitely known but it is believed, like the alkalis, to affect properties of the oxide film forming on the steel.

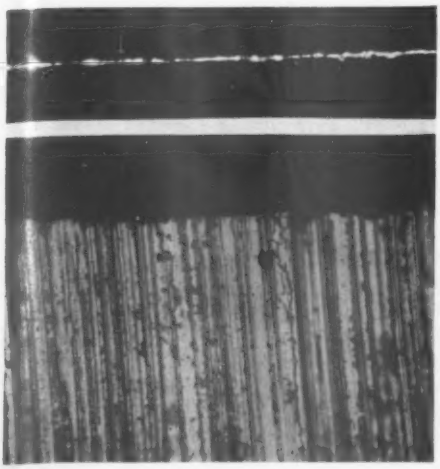

FIG. IV. Edge-on and profile views of poor quality cutting edge on scalpel blade. (x 375)

Experimental

The corrosion tests required a large number of test specimens and it was decided to use a readily available brand of safety razor blade rather than actual surgical instruments. The reasons for using these blades were (a) the supply was plentiful, (b) the cutting edges were uniform and of a high quality not exceeded by the best surgical instruments, (c) the blades were straight and easily photographed, and (d) a readily corrodible plain carbon steel was used in their manufacture. The extent of corrosion and resultant loss in sharpness was measured by microscopical examination of the cutting edge in profile, and edge-on by means of an inverted-stage metallurgical microscope, using vertical illumination. Maximum sharpness has been defined by Kayser (1946) in the following: ". . . the sharpest cutting edges (which unfortunately are only found with any degree of uniformity amongst safety razor blades) are made up of two minute mirror-like facets subtending an angle of 20-24 degrees. The radius of curvature of the extreme edge is approximately 0.00001 inches. A good edge is never saw-like but is essentially straight, even when examined at x500 magnification. The final facet (the facet adjacent to the edge) is for all practical purposes free from scratches and the few present are less than 0.00001 inches deep." The safety razor blades used for the corrosion tests complied with these standards, as shown in Fig. III. For purposes of comparison, the appearance of a poor quality cutting edge, found on a new detachable scalpel blade is shown in Fig. IV.

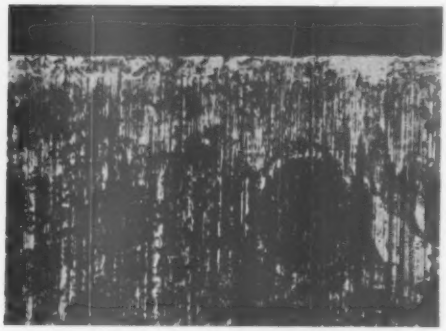

FIG. V. Condition of blade after sterilization in pressure-cooker type autoclave (3 minutes at 30 lbs. per square inch and 270°F). Blade is extensively stained and corroded. (x 150)

Sterilization by moist heat from saturated steam under pressure

Three types of steam sterilizing apparatus were used in the tests, each of which produced its own characteristic results.

(a) *Portable pressure-cooker type autoclave.* This consisted of a metal container of approximately three gallons capacity, fitted with a steam-tight lid and heated by an external gas burner. Three pints of water were placed in the autoclave, the test specimens placed on a tray above water level, the lid fitted and the water heated to boiling. The autoclave was open to the atmosphere through a valve release until all air had been expelled by the steam. The valve was then closed and heating continued until the required temperatures and pressures were reached. Tests were usually carried out for a minimum time of three minutes at 275°F and 30 lbs. per square inch.

Blades sterilized in this manner were invariably badly corroded and unusable (Fig. V). Examination of test blades at intervals during the sterilizing procedure showed that corrosion occurred during the period between placing the blades in the autoclave, and closing the blow-off valve after expulsion of air. This period varied between five and ten minutes. Further tests were performed with blades on which condensation during this period was prevented, by placing the blades flat on a heavy steel plate which had been heated to slightly above 212°F. Blades treated in this manner were found to be free of corrosion after completion of sterilization.

FIG. VI. Condition of blade after sterilization in wall-mounted autoclave (20 minutes at 10 lbs. per square inch and 240°F). Blade is slightly corroded, but in a usable condition. (x 150)

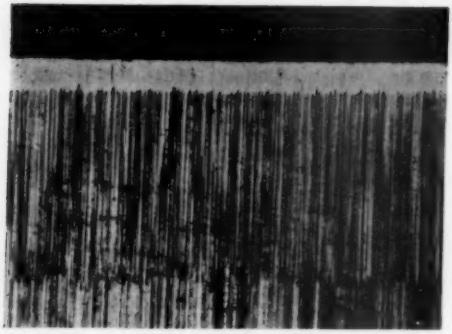

FIG. VII. Condition of blade after sterilization in tube sterilizer (60 minutes at 30 lbs. per square inch and 270°F). Blade is free from corrosion. (x 150)

(b) *Wall-mounted autoclave with external steam supply.* The autoclave was typical of those in hospital use. Air was expelled by blowing in steam from an external steam supply, this requiring approximately ten minutes. The autoclave normally operated at 240°F and 10 lbs. per square inch. Blades sterilized in this apparatus were slightly corroded, but the cutting edges were generally intact, and in a usable condition (Fig. VI).

(c) *Tube Sterilizer.* This was a special apparatus, made up in the laboratory, and consisted of a one foot length of one inch diameter tubing with a release valve at one end, and a presure tight cap at the other. The tube was two-thirds filled with water, and the test blade placed in the small air space. The water was rapidly and vigorously boiled with the release valve open, and after approximately one minute, the valve was closed and the tube placed in an oven held at the sterilizing temperature. The tube was positioned so that the blade was above water level. Melting point tubes were included with the blade to check temperatures reached. Blades sterilized in this apparatus were free from rust, and suffered no visible damage to their cutting edges (Figs. VII, VIII). Temperatures up to 280°F and times of up to six hours were used in some tests.

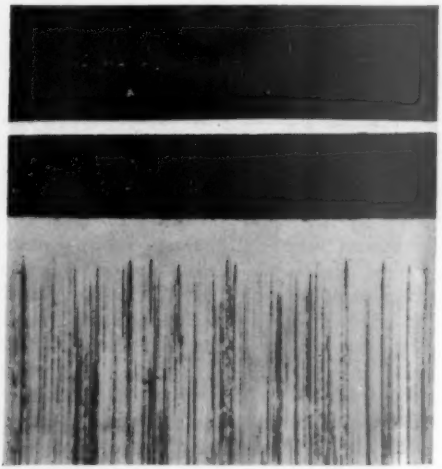

FIG. VIII. Edge-on and profile views of cutting edge of blade after sterilization in tube sterilizer (60 minutes at 30 lbs. per square inch at 270°F). Edge is in perfect condition; cf. Fig. III. (x 375).

Discussion of results

The difference in the results obtained with the three types of apparatus followed from

their method of operation. As was to be expected, no corrosion could be directly attributed to steam under pressure. Test blades were not corroded in the tube sterilizer nor in the portable autoclave when condensation during the blow-off period was prevented. The corrosion must then have been associated with the water condensate. Water condensate must have collected on every test blade at some stage during sterilizing but only in certain cases did corrosion occur.

With the portable autoclave, condensation occurred immediately the test blade was placed in the apparatus and heating commenced. The condensate was in contact with air in the autoclave during the period the water was heated to boiling, and for some time afterwards. The test blade and the condensate lying on it were at a lower temperature than the water until some time after boiling point was reached. These conditions allowed time for the condensate to absorb oxygen from the air in the autoclave, and for corrosion to occur.

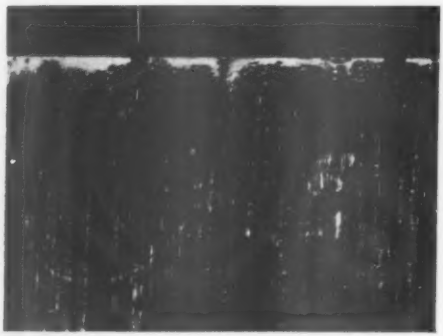

FIG. IX. Condition of blade after boiling in fresh tap water for 15 minutes. Blade is heavily corroded in coarse ground zone, and cutting edge is discontinuous. (x 75)

The conditions in the wall-mounted autoclave with its external steam supply were less favourable for promoting corrosion despite the somewhat longer period required for air expulsion. This was probably because the steam from the supply line, circulating in the autoclave, brought the test blade more rapidly up to temperatures where oxygen solubility tended to zero. The sterilizing tube, having a small air space and a relatively large release valve aperture was rapidly rid of air and insufficient time was available for the condensate to absorb oxygen and set up corrosion.

Sterilization by boiling in aqueous solutions

The tests were performed in open beakers on a hot plate, using Melbourne tap water. The effect of preliminary boiling of water to eliminate dissolved oxygen is shown in Figs. IX and X. The blade shown in Fig. IX was placed in cold water which was slowly brought to the boil, and maintained at boiling point for fifteen minutes; the cutting edge was rendered discontinuous and the coarse ground zone was heavily pitted. The blade shown in Fig X was placed in water whcih had been boiling for some minutes previously. After removal from the water, the blade appeared clean and bright, and only isolated corrosion spots were visible at x100 magnification.

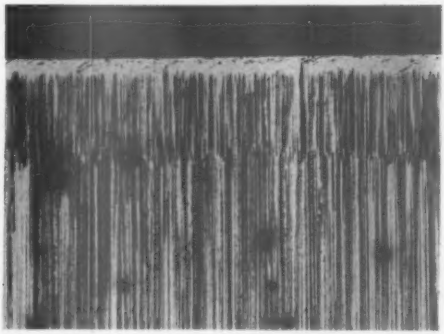

FIG. X. Condition of blade after boiling in previously boiled water. Blade shows few corrosion spots; cutting edge is intact. (x 75)

Test blades were boiled in a solution containing 2 per cent. sodium carbonate (monohydrate), and in a solution containing 0.073 per cent. sodium nitrite plus 0.168 per cent. anhydrous sodium carbonate. The composition of the latter solution was chosen to agree closely with that obtained when using a commercial sterilizing compound, marketed in tablet form. The blades shown in Figs. XI and XII were boiled for six hours. Loss by evaporation was made up by adding cold fresh water. The blades stood in their respective solutions overnight. No trace of corrosion damage was visible microscopically, and the cutting edges retained their sharpness.

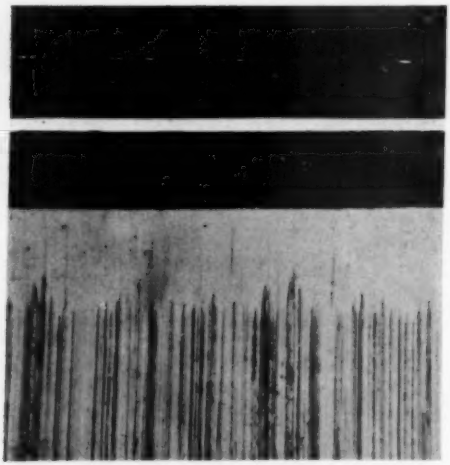

FIG. XI. Edge-on and profile views of cutting edge of blade after boiling for 6 hours in 2 per cent. sodium carbonate solution. Edge is in perfect condition; cf. Fig. III. (x 375)

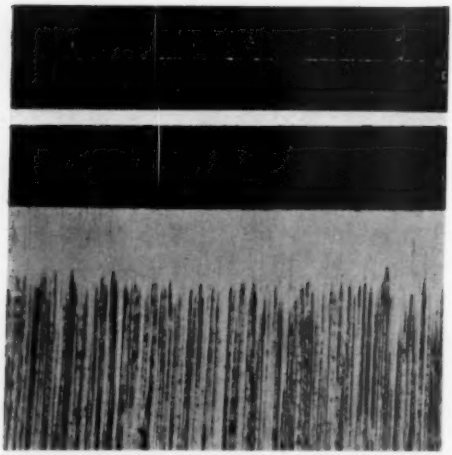

FIG. XII. Edge-on and profile views of cutting edge of blade after boiling for 6 hours in sodium carbonate-sodium nitrite solution. Edge is in perfect condition; cf. Fig. III. (x 375)

Measurements of the pH value were made on the solutions used in the above tests, and for purposes of comparison, on a 0.1 per cent. sodium hydroxide solution. The results were:—

Solution	*pH*
2 per cent. sodium carbonate (monohydrate), freshly prepared	10.4
Above solution, diluted five times	10.4
Above solution, after boiling for three hours	11.2
0.073 per cent. sodium nitrite plus 0.168 per cent. sodium carbonate (anhydrous), freshly prepared	10.8
0.1 per cent. sodium hydroxide, freshly prepared	11.8

Discussion of results

No loss in sharpness was apparent after prolonged boiling, and there was no indication of the need for an anti-corrosion oil. Possibly this is explained by the high purity of the Melbourne water supply whereas the contrary experience of Foster (1949) and others (Warren Harvey, Le May and Shuttleworth, 1947) may have been due to the use of water of high solids content.

During all the sterilizing tests the possibility has been kept in mind that if corrosion did occur it might be intensified at the extreme cutting edge. However, no such tendency was shown; in fact the cutting edges appeared to have a higher corrosion resistance than the flat surfaces in their vicinity. This is particularly evident in Figs. VI and X where the corrosion spots occur at random in the coarse ground zone, and in Fig. VI where the cutting edge is shown intact for most of its length.

CONCLUSIONS

The "temper" of cutting instruments is not seriously affected by the temperatures used in sterilization. Some softening may occur at the higher temperatures with certain instruments, but this would be unlikely to affect their serviceability. The degree of softening depends on the sterilizing temperature, and is practically independent of the frequency and duration of the treatment.

Instruments sterilized by steam under pressure may, under certain conditions, suffer damage by corrosion. The corrosive medium is the oxygen dissolved in the water condensing on the instruments, not the steam itself. Corrosion occurs when the water condensate has prolonged contact with air as a result of

incomplete or slow air expulsion, prior to pressurizing. Small pressure-cooker type autoclaves are unsuitable for steam sterilization of instruments because of their slow rate of air expulsion. Results from autoclaves supplied with steam from an external source and which effect air removal by displacement, will vary according to the design and method of operation of the apparatus. Autoclaves designed to be evacuated before admission of steam should be satisfactory if the steam supply is of good quality. Corrosion is not intensified at fine cutting edges.

Instruments boiled in sodium carbonate and sodium carbonate-sodium nitrite sterilizing solutions do not suffer detectable corrosion damage.

ACKNOWLEDGEMENTS

The investigation originated from an enquiry from Dr. G. I. Howard, Medical Superintendent, Alfred Hospital, Melbourne, regarding heat and corrosion effects during steam sterilization. The author is indebted to Dr. Howard for supplying the surgical instruments which were used as test samples, and for other advice and assistance.

Thanks are due to Mr. H. A. Stephens for his constructive criticism of the paper.

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SPONTANEOUS PASSAGE OF NECROTIC BOWEL

By W. M. Davies and J. D. Hicks

Colac and the Royal Melbourne Hospital

FROM time to time almost unbelievable accidents occur both of ill fortune and good fortune, and the following account is of a remarkable series of events which befell a patient following removal of her gall-bladder.

Clinical Record

Mrs. L.S., aged 59, complained of repeated attacks of biliary colic. Numerous calculi were outlined in the gall-bladder by a cholecystogram and on the 7th April, 1952, under pentothal, cyclopropane, and curare, a cholecystectomy was performed.

At operation the gall-bladder was found to be surrounded by adhesions and filled with large stones. Some difficulty was experienced in dissecting out the duct system and, during this procedure, the clamp on the cystic artery came off resulting in severe haemorrhage which was finally controlled by ligature. The remainder of the operation was normal and one drain tube was inserted down to Morison's pouch. On return to the ward the patient's condition was poor, but improved with anti-shock treatment. During the succeeding two days there was some drainage of blood from the drain tube and the temperature was elevated to 99.6°F.

Two days later the drain tube was shortened and there was still a good deal of dark blood-stained discharge from the wound. The patient's general condition remained good, but the drainage of dark blood from the wound continued and she was troubled by "wind pains." During the following week she had a good deal of severe abdominal pain and and on two occasions her temperature rose to 100.6°F. Following an enema on 15th April she developed diarrhoea. This became rather troublesome and failed to respond to *Mist. Kaolin Co.*

On the tenth post-operative day, because of the continued temperature and the absence of positive abdominal findings, she was given streptomycin 0.5 grams twice daily. At this time the haemoglobin was 72 per cent. of normal and the leucocytes 18,500 per c.mm. with a normal distribution. She continued to have abdominal pain and diarrhoea but there were no positive signs until 21st April, when pelvic examination revealed the presence of a mass palpable through the posterior fornix. The mass was hard and tender, but not fluctuant. Blood examination showed a haemoglobin value of 68 per cent. and leucocytes 14,000 per c.mm., still with normal distribution. She was given a transfusion of one pint of blood.

Seventeen days after operation, she passed per rectum a dark tubular mass approximately 18 inches in length, which had the appearance of altered bowel, and this was considered to be due to sloughing of an intussusceptum. Following this her condition improved. On section of the necrotic material a definite muscular layer could be made out and with fragments of other layers of the wall of the bowel, the structures being in outline only, it was concluded that the material passed consisted of the whole thickness of the bowel wall. Whether the bowel segment passed had become necrotic as the result of a mesenteric thrombosis or was portion of an intussusceptum could not be determined. The pelvic mass was still palpable.

On the 28th April she was very much better, had no pain, no diarrhoea, and blood examination showed: Hb. 90 per cent., R.B.C. 4.24 x 10^6 per c.mm., C.I. 1.07, W.B.C. 8,400 per c.mm. with normal distribution. However, in the following days she again developed severe diarrhoea, with loose dark stools. The

temperature became swinging in character and she suffered a good deal of cramping abdominal pain. A cystic swelling could be palpated in the right hypochondrium. In view of the swinging temperature and recurrence of diarrhoea laparotomy was performed on the 9th May, 1952, under pentothal, cyclopropane and curare.

Second operation

The abdomen was opened through a lower right paramedian incision. A cystic swelling containing altered blood was present in the right hypochondrium. The whole of the descending colon from the splenic flexure to the recto-sigmoid junction was firm, thickened, and walled off from the remainder of the peritoneum by adhesions. There was a fistula between the sigmoid and a coil of the upper ileum. This was dissected off and the mucosa of the sigmoid colon was found to be gangrenous with almost complete obliteration of the lumen. The bowel perforations were oversewn and a drain tube passed down to the recto-sigmoid junction. Transverse colostomy was performed. Drainage of the cystic swelling in the upper abdomen was carried out from the outer end of the original Kocher incision. The patient's condition throughout the operation was satisfactory.

There was profuse drainage from the tubes, both in the upper abdomen and the pelvis, and after three days the colostomy functioned satisfactorily. The patient was maintained on intravenous therapy and gastric aspiration for four days, after which she was able to take oral fluids and her condition improved considerably. However, discharge from the pelvic tube continued to be profuse while the drainage from the upper abdomen became progressively less and the tube was removed on the fifth day. This state of affairs continued until the 20th May when the stab drain in the upper abdomen again commenced discharging and finally on the 23rd May the wound in the upper abdomen broke down and had to be resutured. Despite resuturing the wound did not heal well and drainage continued from both upper and lower wounds. The drainage from the lower wound was dark altered blood containing a good deal of mucus and was extremely profuse. However, over the next two weeks this became progressively less and finally one month after resuturing both of the wounds were dry. The colostomy was functioning very well and on the 12th July, 1952, she was discharged home, three months after the original operation.

During the succeeding ten months she remained well, the colostomy functioning twice daily and her general condition improved steadily. On the 5th May, 1953, she was re-admitted to hospital for closure of the colostomy and anastomosis. Pre-operatively, she was given phthalylsulphathiazole 1 gram four-hourly and streptomycin 0.5 gram twice daily and was placed on a non-residual diet. The colon was washed through from the colostomy and the rectum washed out on two occasions prior to operation.

Third operation

On the 11th May, 1953, colic anastomosis was performed under pentothal, endotracheal cyclopropane and curare. The abdomen was opened through a lower left paramedian incision and numerous adhesions were separated. The splenic flexure was located and the bowel lumen found to extend for approximately three inches into the descending colon. The remainder of the descending colon was formed of a fibrous cord and was well walled-off. There was some difficulty in locating the rectal stump as the entire pelvis was filled with coils of small bowel densely matted but the stump which was adherent to the uterus was freed and brought up. The bowel was divided at the recto-sigmoid junction where a sharp division could be seen between the rectum below, with a lumen and the sigmoid where the lumen was completely obliterated. The splenic flexure was freed, drawn downwards and anastomosed with two layers of interrupted silk to the rectal stump, without tension. A drain tube through a stab wound was placed in the region of the anastomosis. The colostomy which was to the right of the midline was left intact.

The patient continued on a non-residual diet, sulphathiazole and streptomycin post-operatively, and her condition was satisfactory

apart from her temperature which rose to 101°F on two occasions. On the third day the colostomy opened spontaneously and the drain tube was removed on the fifth day. The wound healed rapidly and the sutures were removed on the ninth day.

On the 21st May she was troubled with offensive discharge from the site of the drain tube and she had offensive loose stools from the colostomy. The patient passed flatus and a small amount of faeces per rectum. On the 23rd May, fourteen days after operation barium sulphate was inserted from the colostomy and the continuity of the bowel confirmed. There continued to be some drainage from the stab wound but the patient's condition was excellent.

On the 4th June, 1953, the colostomy was closed. From this stage onwards the bowel continued to function satisfactorily and the colostomy wound healed rapidly. She had some pain in the left side in the region of the stab wound, but this finally subsided and on the 15th June she was discharged. Since discharge, she had had attacks of pain in the region of the stab wound, with intermittent discharge, but the condition subsided over a period of months and she was in excellent health two years after the final operation.

DISCUSSION

In summary, the patient passed eighteen inches of necrotic bowel on the seventeenth day after cholecystectomy, following attacks of abdominal pain and diarrhoea. From the findings at operation a month later it appeared that the descending colon became necrotic and was sealed off by adhesions. To counteract this blockage a fistula between the sigmoid and the ileum had fortunately developed, allowing the excretion of bowel contents.

In spite of the breakdown of the upper abdominal wound due to the underlying haematoma, healing occurred and the patient went home with a colostomy after three months. At a third major operation the descending colon was found to be reduced to a dense fibrous cord. In spite of dense adhesions, both in the splenic flexure and in the pelvis, the normal bowel was reconstituted.

The spontaneous separation of a segment of necrotic bowel is a rare phenomenon, but it has been observed before. In 1952 Welsh recorded a case of a man of 74 who collapsed with severe upper abdominal pain. After two or three days vomiting he recovered. A diagnosis of mesenteric thrombosis was suggested. Five weeks later he passed two feet of macerated intestine. Three other cases of spontaneous separation of necrotic bowel, following intussusception, were mentioned at the meeting at which Welsh presented his case. In one patient the intussusception was ileo-caecal, and in the other two the intussuscipiens presented at the anus. In these cases sloughing of the colon was followed by spontaneous healing and it was difficult to demonstrate the site of anastomosis.

In the case reported here, it appears more likely that the necrosis of the descending colon was due to a thrombosis of the vascular supply, of the left colic artery for instance, than to an intussusception, the lack of a mesentery restricting any infolding of the bowel. The retroperitoneal situation of the affected portion was probably responsible for the succesful prevention of a widespread peritonitis. As the damage extended into the sigmoid colon it is not unexpected that involvement of neighbouring surfaces might occur and the formation of an ileo-sigmoid fistula resulted. This somewhat fortuitous complication allowed the passage of bowel contents, possibly more fluid than usual by virtue of the short-circuiting of the major portion of the colon. The closure of this fistula necessitated a transverse colostomy. The localized haematoma in the upper abdomen and the inflammatory collection in the pelvis were potent factors in delaying healing but, in spite of the upper abdominal wound breaking down, the patient recovered steadily.

As she continued to improve and remained well during the succeeding months, closure of

the colostomy and anastomosis of colon to the rectum was contemplated. By the time this procedure was actually carried out, the portion of the alimentary tract from which the whole thickness of the bowel had been cast was reduced to a fibrous cord hidden behind dense peritoneal adhesions.

The successful negotiation of the restoration of continuity with the rectum carried out under such technically difficult conditions excites the wonder of the pathologist who finds the resources of many a patient's peritoneum inadequate to withstand manipulations of much lesser extent.

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LIVER INJURIES

THEIR ASSOCIATION WITH MASSIVE HAEMATEMESIS AND MELAENA

By Vernon Barling

Sydney

THE purpose of this communication is to bring to the notice of clinicians the fact that massive haematemesis and melaena can be attributed to a prior non-perforating hepatic injury. In any case of obscure gastro-intestinal bleeding one should enquire into the possibility of such prior hepatic trauma. In all cases of liver injury a careful watch should be kept for the occurrence of bleeding from the alimentary tract.

The association of massive bleeding into the bowel with hepatic injuries receives no mention in most text books of surgery. The cases reported in the literature show that haematemesis and melaena were not attributed to an hepatic injury until a late stage in their management; in some instances the association was not suspected until revealed by post-mortem examination.

"Traumatic Haemobilia" (a term introduced by Professor Philip Sandblom, of Lund, Sweden) does not emphasize adequately the fact that the bleeding may be massive. It merely implies the presence of blood in the biliary tree following liver injury. The severity of the bleeding that can occur is the important aspect of Traumatic Haemobilia and a wider dissemination of this fact is important. This importance is underlined by the reports of "blind gastrectomies" being done for massive haematemesis and melaena in cases whose prior liver trauma was the real cause of the bleeding. This surgical crime is aided by the fact that haemorrhage into the biliary tree following injury may be surprisingly delayed. In some cases the interval has been two to three months. Wider knowledge of these facts will focus therapy on the affected viscus and the frequency of reports of fruitless laparotomies will steadily decrease.

A Typical Case Report

M.W., aged 17 years, was out shooting kangaroos on his motor bicycle and was thrown across the handle bars when he went over a hidden tree stump on the 6th July, 1954.

Upper abdominal pain, vomiting, a tinge of jaundice, and upper abdominal rigidity with generalized muscle guarding led to a diagnosis of hepatic rupture; the site of impact of the handle bars being evidenced by the presence of bruising over the lower right costal margin, anteriorly.

Laparotomy on the 7th July, 1954, revealed a right lobar hepatic tear with a large tributary of the right hepatic duct visible in the torn surface. An attempt was made to control bleeding points, the hepatic ductule was ligated and the lacerated surfaces apposed with deep mattress sutures, including the omentum.

The patient made satisfactory progress and was about to be discharged from hospital some two weeks later when an attack of severe abdominal pain occurred, associated with a small haematemesis.

Three similar attacks of cramping abdominal pain followed with further copious blood stained vomitus. He was transfused and transported from the country hospital to Sydney, with the drip transfusion running.

On examination in Sydney it was considered that the patient had an adhesive obstruction, the presence of blood in the vomitus being assumed to be caused by his jaundice and consequent vitamin K deficiency.

At operation on the 31st July, 1954, adhesive obstruction to the lower small intestine was found but no real explanation for the haematemesis was offering. The external surface of the liver appeared normal, the great omentum covered over the inferior aspect of the liver and blocked an adequate view of the common bile duct; this did not appear dilated and it was not considered wise to detach the omentum from the lacerated area.

By the 3rd August, 1954, the patient was feeling much better with a soft non-distended abdomen. His bowel action was satisfactory in amount and colour, and his jaundice was almost completely vanished. On the 17th August, 1954, he was discharged from hospital.

Within a few days he had reported again with a further attack of pain and associated severe haematemesis and melaena. He was again slightly jaundiced. He was re-admitted and a barium meal was carried out in an attempt to elucidate the problem of the haematemesis. This revealed a "cup and spill" type of stomach and in view of his youth this deformity was considered as being due possibly to a volvulus of the stomach.

On the 21st August, 1954, a further laparotomy revealed multiple peritoneal adhesions but no volvulus of the stomach nor any other pathological feature. The patient's general condition was at a very low ebb and it was not until ten days later that he had recovered to any degree. Nevertheless from then on for the next two weeks the patient experienced typical bouts of pain which he came to recognize and could always predict the haematemesis and melaena which invariably followed sooner or later after such attacks of pain. These started in the midline posteriorly in the region of the 8th to 11th thoracic spines and passed forwards to the epigastrium and right hypochondrium. The pain was severe and described as "bursting" in character initially and followed soon after by griping epigastric pain. Within 6-24 hours the patient's jaundice would increase in depth and either a haematemesis would occur early or a melaena stool later, with a concomitant fall in blood pressure and a falling off of the patient's general condition. It was only at this period that the true diagnosis was suspected. An intensive review of the literature brought the term haemobilia to light and articles on traumatic haemobilia revealed a striking similarity between this case and those reported.

Mr. Rodney Maingot, on a visit to Sydney, saw the patient in consultation and agreed with the diagnosis of Traumatic Haemobilia with massive gastro-intestinal haemorrhage. He suggested the possibility of a radical cure being effected by a right hepatic partial lobectomy should the pains and bleeding proceed indefinitely. However, this was not necessary as the patient's pains gradually became less severe and less frequent and he was discharged from hospital some ten weeks after the initial accident.

It is now a year since discharge from hospital and he remains in excellent health having gained two stone in weight, and professes to be much better than before the mishap.

REVIEW OF LITERATURE

Thirteen cases of a type similar to the case described have been found.

The following facts emerge:

1. Of the total of 14 cases there were six deaths—mortality 43 per cent.
   (a) In four of these deaths no operation was performed and they all died, though one survived three months.
   (b) In two cases packing with gauze was carried out prior to death—in one of these cases a gastrectomy was subsequently done in an attempt to prevent bleeding but both eventually died.
2. Multiple laparotomies without significant findings is the common story—it is only at about the third to fifth laparotomy that blood has been suspected in the biliary tree. Other additional procedures have been—
   (a) Cholecystostomy—2 cases.
   (b) Cholecystectomy—2 cases.
   (c) Choledochostomy—1 case.
   (d) Gastrectomy—1 case.
   (e) Packing with gauze—4 cases.
3. All injuries were of the subcutaneous variety. Horse kicks, falls from horses, bicycles, sled, football, and car accidents account for the majority of cases—often a prominent object such as a jar or bottle is found in the pocket in a position calculated to concentrate the requisite force on the lower right costal margin. Actual fracture of the ribs is rare.
4. Trauma produces a subcutaneous laceration of the right lobe of the liver:
   (a) This may be complete—that is to say, it may come to the surface (usually on the inferior surface) and cause blood and bile to escape into the peritoneal cavity. At laparotomy repair of the ruptured liver allows the formation of a central cavity in the right lobe of the liver.
   (b) This may be incomplete and not come to the surface. The patient recovers from his initial shock and his subcapsular or central cavity does not give rise to peritoneal reaction so that the initial conservative treatment is successfully followed.

In all cases infection and/or antolysis ensues in the liver forming the wall of the cavity with resulting secondary haemorrhage.

5. Bleeding from the central right lobar cavity occurs into the biliary tree with consequent:
   (a) Shock.
   (b) Clot colic.
   (c) Obstruction of the biliary tree and jaundice.
   (d) Haematemesis and melaena.

   It is noteworthy that—
   (e) Blood can clot in the presence of bile.
   (f) The bleeding is periodic and there may be a delay of some weeks prior to its initial appearance.
   (g) The bleeding may be of such volume as to cause massive haematemesis and melaena and severe shock.

6. Distension of the cavity in the liver causes pain. This pain is classically central, commencing in the back in the lower thoracic region and passing through to the epigastrium; it may also be felt in the right hypochondrium presumably due to gall-bladder distension. The pain precedes haematemesis and melaena and is associated with varying degrees of shock, depending on the amount of blood lost.

7. Jaundice of mild degree is a common feature. This is due to clotting of the blood in the biliary tree with partial obstruction.

8. Failure to recognize the condition is almost universal. This accounts for—
   (a) The high mortality, and
   (b) the frequency of fruitless laparotomies in these cases.

TREATMENT

1. Make correct diagnosis.

2. In view of high mortality with no operative procedure the following lines of therapy are suggested:
   (a) Evacuation of the cavity and collapse by multiple deep sutures. A drainage tube might be placed in between apposed surfaces through which local antibiotics and streptodornase—streptokinase may be injected. Large ducts and vessels should be ligated.
   (b) The raw edges of the liver may be grafted with skin and packed in with gauze until taken. This would be worthwhile in smaller tears with a large "bridge" of intact liver deep to the laceration.
   (c) Excision of the most lateral or right portion of the liver and skin grafting of remaining raw surface with drainage. This would be more suitable were the bridge of liver tissue negligible and that portion of the liver therefore virtually useless.

3. Biliary drainage would not appear to be a logical procedure unless the obstructive element is maximal. As a confirmation of the diagnosis aspiration of the biliary tree would be a valuable procedure.

4. It would appear to be fundamental to avoid creating a central hepatic cavity when repair of a lacerated liver is carried out at laparotomy.

SUMMARY

A further case of Traumatic Haemobilia is reported. It is stressed that the associated bleeding into the alimentary tract may be massive. Methods of treating hepatic injuries in order to prevent the formation of a central hepatic cavity are outlined.

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HAEMOPERITONEUM FROM ENDOMETRIOSIS

By Evan Raine

Wellington, New Zealand

RUPTURE of endometrial cysts is an uncommon cause of acute abdominal symptoms. Pratt *et alii* (1952) have reported ten cases seen at the Mayo Clinic between 1933 and 1951. Up to 1945 only 15 cases had been recorded in the literature. The average age of Pratt's cases was 30 and although seven were married only two had conceived. He states that extensive rupture may mimic a ruptured ectopic pregnancy, ruptured follicle or luteal cyst, torsion of an ovarian cyst or acute appendicitis. The onset is sudden with low abdominal pain and peritoneal irritation but characteristically the onset is less acute than with ruptured ectopic pregnancy. None of his cases showed acute collapse. In the ten cases reported chocolate coloured fluid was found; the amount was not large.

The purpose of this report is to record a further similar case.

Case History

Mrs. G.M.B., aged 27, was admitted to Wellington Hospital on 3rd November, 1954. She complained of vaginal bleeding over a period of four days and lower abdominal pain for two days up to and including the day of admission.

In 1948 she had had an operation in England in which the cervix was cauterized and a ventrosuspension of the uterus was done. She had been informed, at this time, that she was suffering from endometriosis and she stated that this had been proved histologically.

She had one child aged 13 months.

Her last normal menstrual period began on 28th September, 1954. A scanty period began on 31st October, six days late. Her periods normally occurred every twenty-six days and had been quite regular. Since the operation in 1948 she had not suffered from dysmenorrhea. On the day of admission she had passed clots from the vagina and stated that over the past six or eight months, in the middle of the menstrual cycle, she had had pain in the left iliac fossa. There were no other symptoms.

On examination: she appeared to be a healthy young woman. The blood pressure was 114/80 mm. Hg. The abdomen was tender low down in each iliac fossa but there was no abdominal guarding. Vaginal examination revealed blood coming from the external os. There was some *ectropion* of the cervix. Both fornices were tender, more pronounced on the left side. There seemed to be some fullness of the right fornix. Nothing abnormal was found in the urine. The haemoglobin was 11.8 grams per cent. The white cells were 10,200 per cmm. with 85 per cent. of neutrophils.

On 4th November she was nauseated and, in the evening, complained of lower abdominal pain. A "straight" X-ray of the abdomen showed nothing significant.

At 8 p.m. on the following day (5th November) she suffered sudden severe lower abdominal pain. On examination there was central tenderness low down in the abdomen but no guarding of the muscles. She appeared paler and the blood pressure was 98/60 mm. Hg. She was given 50 mg. of *pethidine*, with relief of the pain. Microscopic examination of the urine was again normal and the haemoglobin was 11.6 grams. At this stage it was considered that she had possibly been bleeding from an endometrial cyst.

On the following day, 6th November, she was seen in consultation by Mr. H. K. Pacey who felt that the possibility of a ruptured ectopic pregnancy on the right side should be seriously considered. Her haemoglobin was then 11 grams per cent.

At laparotomy, on 6th November, the right fallopian tube was found to be engorged with blood which was infiltrating the mesosalpinx and mesovarium. This was associated with a large pelvic haematocele. The colon and rectum were adherent to the uterus and right ovary. The right ovary contained a simple cyst which was not bleeding. In the left fallopian tube there were five small bluish-black deposits within the lumen of the tube and these had the appearance of endometrial deposits. The right tube and ovary were excised together with the appendix. At the conclusion of the operation the blood pressure was 120/80 mm. Hg. Two days later the haemoglobin was 13.7 grams per cent.

Dr. D. Reid has supplied the following pathological report: "The specimen consists of a fallopian tube and ovary with a lot of induration. The fallopian tube has been slit open and its lumen is dilated. A small amount of haemorrhagic material is attached to the outside of the tube. No clot is present in the lumen. The ovary measures 3 cm. across and it contains a corpus luteum with a haemorrhagic centre and it measures 2 cm. across.

"Microscopic diagnosis: Endometriosis of tube and ovary. The stroma shows a pronounced decidual change of the order usually seen in pregnancy but no villi or other confirmatory evidence is seen and it may represent menstruation only. The appendix shows increased fibrosis."

When seen in the outpatient department on 26th January, 1955, this patient was well and had had two normal periods since the operation. She had not had any dysmenorrhea.

This patient has been seen twice since that time complaining of intermenstrual pain. Her symptoms have been improved by the use of *Ethisterone* 10 mg. three times daily by mouth except when menstruating.

DISCUSSION

A ruptured ectopic pregnancy was seriously considered in the diagnosis because the patient, who was a trained nurse, knew of her condition and had been specially desirous of adding to her family. To offset this her period was only six days overdue and the amount of vaginal bleeding was far greater than that normally seen with a ruptured ectopic pregnancy. The appearances at operation indicate that she had bled from a deposit of endometriosis in the right fallopian tube and that this haematosalpinx had bled into the right broad ligament and into the cavity of the pelvis. In view of the deposits of endometriosis noted at operation in the left fallopian tube the ultimate prognosis is not good.

SUMMARY

A further case of haemoperitoneum from endometriosis is reported.

ACKNOWLEDGEMENTS

I should like to thank Mr. Eardley Button under whose care this case was admitted and also Mr. H. K. Pacey who saw the case in consultation.

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Books Reviewed

PRESERVATION AND TRANSPLANTATION OF NORMAL TISSUES. A Ciba Foundation Symposium.

Editors: G. E. W. WOLSTENHOLME and MARGARET P. CAMERON. London: J. and A. Churchill Ltd., 1954. 8" x 5¼", xii plus 236 pp., 55 illustrations. Price: 25s.

At the outset of the report of the Ciba Foundation Symposium on the preservation and transplantation of normal tissues we are reminded that while autonomous grafts are ideal in clinical work they are not always obtainable, as in the case of major vessels and the cornea. With very good reason, then, the discussion is directed toward the problem of homografts, the reaction of the host to them and their fate, their function whether active or passive, methods for their preservation and the possibility of modification of their antigenicity. There is a useful outline by Medawar of the establishment of homografts, the latent period, the development of acquired immunity by the host and the resultant breakdown of the graft as exemplified by skin homografts, and a discussion of the nature of the immunological responses.

Assuming that all homografts will eventually be destroyed by the immunological reaction and their cells be entirely replaced, they may yet fulfil a biomechanical function, acting as a framework upon which the host tissues regenerate a new part. Pate describes some experiments on dogs which suggest that viability of such grafts is not only unnecessary but may be a liability. In these experiments freeze-dried grafts were as good or better than fresh. Longmire and Cannon review clinical and experimental evidence on graft vitality and conclude that its importance to ultimate clinical success may vary from one tisue to another. In this connection they emphasize the value of dividing homografts according to one's clinical object into those which are inert (homostatic) and to which the above considerations apply, and those whose cells must continue to grow and reproduce (homovital), that is they must retain their vitality.

Whether such survival of homografts in the host is possible is the subject of a number of papers which follow on endocrines. The criteria of survival in most of this work are functional, but in addition Deanesly provides some histological evidence that ovarian homografts may survive in the host for some months and Jones describes some remarkable results of grafting newborn adrenal tissue into adrenalectomized rats. The grafts survived in a substantial proportion of hosts up to nine to eleven months and were histologically sound and functionally essential. A possibly useful idea is expressed that endocrines may be able to resist immunity reactions because of controlling stimuli of other endocrines.

Smith and Parkes, Billingham and Lovelock discuss the conditions for maintaining viability in stored grafts and particularly the use of glycerol saline.

On the other hand there is a possibility, discussed by Pate for vessel and by Saunders for nerve homografts, that the homograft reaction may be reduced with advantage to the graft by freezing or freeze-drying of the graft, which perhaps alters its antigenicity. Hufnagel goes further to claim that even heterografts can be so modified by freeze-drying as to become useful clinically as scaffolds.

Special problems of skin, nerve, vessel and cornea grafts are discussed. The papers generally are informative in a field where more information is badly needed.

The binding of the book is not of the same standard, some of the pages in the copy received being loose, others reversed and out of order.

FRACTURES AND JOINT INJURIES. (Volume II.)

By Sir REGINALD WATSON-JONES, B.Sc., M.Ch. (Orth.), F.R.C.S., F.R.A.C.S.(Hon.), F.A.C.S.(Hon.). Fourth Edition. Edinburgh: E. and S. Livingstone Ltd., 1955. 9¼" x 6½", viii plus 628 pp., 904 figures, X-rays and diagrams. Price: £6 stg. (per set of two volumes).

It is three years since Volume I of this edition was published — after reading Volume II it must be conceded that it has been worth waiting for. Once more it can be recorded that this work is incomparably the best of its kind in the English — and probably any language.

Volume II has been largely re-written since the previous edition of 1943. Some new chapters have been added, notably on facio-maxillary and chest injuries. Another new chapter describing Stoke Mandeville and similar centres where that most pitiful of all patients, the paraplegic, is given new hope and life, is of great local interest — for similar institutions are long overdue in this country. The author's well-known enthusiasm for rehabilitation, which reached its fulfilment during the war, when he was Civilian Consultant to the R.A.F., is felt in full measure not only in the chapter dealing with this all-important aspect of fracture treatment, but in almost every page of the book. It is not misplaced. The chapter on unusual and instructive cases has been omitted but one recognizes many of the old illustrations appearing throughout the text in appropriate places. One can only deplore the omission of that most unique and exciting of all chapters entitled "Highlights of Fracture Treatment" and trust that the author will see fit to restore it in future editions.

A few matters arise that are worthy of comment. Many surgeons have used methods similar to that described by Charnley for reducing supracondylar fractures at the elbow in children and prefer it to that described in Chapter XX. Plaster casts after reduction, in our hands, serve no useful purpose, and at times, by a combination of weight (however light) and leverage, appear to encourage backward angulation of the lower fragment. It is pleasing to note that there is a place, larger than many will admit, for doing nothing to old un-united fractures of the carpal scaphoid. However we cannot subscribe to the view that the treatment of delayed union in fractures of this bone is prolonged immobilization. For how long? Three, six, nine, twelve months says the author — or even longer until union is sound. Most emphatically we disagree. The author too claims that successful results after bone-grafting are

not due to the graft at all but merely to the continued immobilization after operation. This view will not be generally accepted, especially as such successful results can generally be recorded three or at most four months after operation, not, be it noted, six, nine, twelve or even more months later. And having stated this, we now record our entire agreement with the author that grafting of delayed or non-union in scaphoid fractures offers disappointingly little towards the solution of the problem.

The discussion on slipped upper femoral epiphysis is not up to standard. Much emphasis is laid on the importance of lateral X-rays in the early diagnosis of slipped epiphysis. Surely it is more important that the lesion can be diagnosed just as easily and as early by an ordinary A.P. view, a fact which Fig. 1060 fails to illustrate. Unless this is widely known many cases will be missed in that all-important phase that many will still prefer to term—for want of a better name—the "pre-slipping" stage. Not enough is made of the fact that there are two distinct types of slipped epiphysis — the "sudden" and the "slow," and nothing at all of the even more important fact that within a very short time — a matter of a few days only — a "sudden" slip becomes a "slow" one. The sudden or acute slip is virtually a fractured neck of the femur, and should be treated in exactly the same way. But — and here again we take issue with the author — there is less risk in performing a gentle manipulative reduction of an acute slip in the operating theatre under X-ray control, than there is in applying skin traction to the leg. We quote "it will be evident within a week or two whether or not the correct position has been achieved." This may be too late and the opportunity which — we emphasize — *never again presents* — of reducing the displacement and obtaining a hip that is indistinguishable from normal, may be lost.

An interesting development is the conception that abduction and adduction intra-capsular fractures of the neck of the femur are but different stages in the same injury. We prefer to nail most impacted fractures of this type because too often in the past have we been mortified to see one disimpact while under observation and treatment. They all unite without complications. It is, in fact, the only fracture in this region of which this can be said — but only if it is nailed.

Few surgeons outside the north-west corner of the U.S.A. would today be bothered with well-leg traction or any method other than open reduction, in treating subtrochanteric fractures of the femur. Those too low for a nail and plate are ideal for intra-medullary nailing. We agree entirely with the author in restricting this admirable method of internal fixation to the upper half of the femur, the shaft of the humerus and ulna. We respectfully suggest that there is never the slightest need to use the guide wire as it is just as easy to insert the nail itself in a retrograde fashion into the upper fragment at the fracture site. It is, however, a wise precaution to have extraction "eyes" at each end of the nail! We do not use a plaster spica post-operatively — in fact, in cases where one has been used union has taken place more slowly. A Thomas splint without traction for six weeks followed by a caliper — which the author deplores — is a routine that has given a minimum of trouble and uniformly excellent results.

A new operation for the relief of recurrent forward dislocation of the ankle joint — a condition far more common than is generally realized — looks technically interesting. Should it prove as successful as the well-known tenodesis for recurrent lateral dislocation of the ankle joint, it should become a standard procedure. We are not sure that the new classification of fractures and fracture-dislocations about the ankle joint is really much better than the old — and after all that can be the only reason for discarding something that has served its purpose quite well for 30 years! If the new classification has real merit it is in the emphasis laid on ligamentous damage as an essential part of the general picture. We note that the disabling effect of avulsions of the inferior tibio-fibular ligament is properly stressed. We ourselves must confess our inability to reduce on all occasions the upward displacements of the posterior "malleolus," and in certain circumstances when it is a large fragment resorting to open reduction and internal fixation by means of a judiciously placed screw.

It is surely doubtful whether open reduction and reconstruction of the sub-talar joint after certain fractures of the os calcis will achieve much, and we felt a little "let down" by the rather cursory dismissal of those very worrying and diversified crush fractures of the forefoot in one paragraph. There is no need to be old-fashioned and remove depressed metatarsal heads through a difficult dorsal approach. Incisions in the sole of the foot heal perfectly — in fact it is the only skin incision of which, after a year or two, no trace whatever can be found.

Troublesome recurrent subluxations in the cervical spine ofen occur in spite of completely adequate initial treatment, and we have found that something more solid than iliac bone is required to maintain stability after operation. The horrible pictures on pages 1004-1005 certainly constitute a strong case against operations on paraplegic patients — but there can always be produced the odd patient who has been saved from a living death—or Stoke Mandeville if he is lucky — by early operative decompression. For which would the average surgeon rather be responsible?

The author has set his own standards, and by those standards is this volume judged. These few criticisms appeal as relevant to the point where the book falls short of perfection. It will be realized at once that in a work of this magnitude these minor strictures are of little real account — and for that matter arise largely from personal differences in practice. We applaud this volume together with Volume I, as representing the very best in British surgery, and in doing so pay a tribute to the publisher, who once again has produced a book of faultless quality.

One last word — Australasian surgeons will take grave affront if the name of the late Sir George Syme, on the title page, is not spelt correctly in subsequent reprints.

THE SEQUELAE OF AMPUTATION.

By KEITH C. BRADLEY, F.R.A.C.S. Melbourne. Trustees of the Services Canteens Trust Fund (Australia), 1955. 8½" x 6", vii plus 236 pp. Price: 10s.

This important book is the outcome of an intensive research into problems of amputees carried out by the author since 1951 and financed by the Services Canteens Trust Fund. It contains a most exhaustive critical review of the literature on the local and general effects which follow amputation; indeed it is doubtful if a more complete review has ever been written in this field for the author commences with Ambrose Pare in the XVI century and ends with the voluminous literature following the Second World War.

The major portion of the book is taken up with a discussion of phantom limb in all its diverse forms, but particularly those in which pain, either in the stump or in the phantom, is the predominant symptom. Many case histories are detailed, a feature of which is the number of amputees examined whose symptoms have occurred since the 1914-18 war. There is a careful analysis of the various forms of treatment of painful stump and stress is laid on the percussion of stump neuromata and ultra-sonic therapy both of which proved effective in a number of cases.

The list of references extends to 21 pages, itself a valuable portion of the book. The author points out the lack, in Australia, of adequate rehabilitation centres for amputees, both service and civilian. It is a poor commentary on Australian medicine that no facilities exist on the lines of those set up by the British Ministry of Pensions at Roehampton. It is to be hoped that appropriate authorities take heed of the material contained in this book.

The author is to be congratulated on an excellent piece of research, the publication of which has provided a reference work which must be consulted by all who are interested in the care and treatment of amputees.

The Trustees of the Services Canteens Trust Fund deserve credit for their foresight in providing the money necessary for carrying out this valuable project.

SURGERY OF THE SYMPATHETIC.

By ALEXANDER LEE McGREGOR, F.R.C.S.(Eng.), M.Ch.(Edin.). Bristol: John Wright and Sons Ltd., 1955. 10" x 7", vi plus 192 pp., 101 illustrations. Price: 30s.

This book should form an easily accessible reference for the surgeon interested in the surgery of the autonomic system of nerves. It is not comprehensive but is a guide to the essentials. The short outline of anatomy is clearly set out although there is at times a tendency to oversimplification. This is so in the case of the superior and inferior hypogastric plexuses.

Fig. 12 may give the impression that the mixed vago-glossopharyngeal nucleus lies medial to the sulcus limitans. Actually this mixed nucleus extends across this line.

In Chapter IV occurs what seems to be a magnificent understatement. "Voluntary motor function is served by the simplest of plans — the motor impulses commence in the Betz cell of the motor cortex." The Betz cells give origin to only a portion of the pyramidal fibres and voluntary motor function depends on a complex integration of nervous impulses.

The author rightly points out that sympathectomy plays a doubtful part in the treatment of cerebral thrombosis. Before performing sympathetic block or sympathectomy for cerebral thrombosis one should exclude haemorrhage and internal carotid artery thrombosis by performing lumbar puncture and angiography. It is clearly pointed out that in general a pre-ganglionic has little to offer over a post-ganglionic sympathectomy.

Relapse may occur after sympathectomy and if early may be due to an incomplete operation whilst regeneration is a factor in late relapse.

The book contains a good clinical presentation of sympathetic derangements. Many would feel however that blood vessel grafts are of limited value where there is generalized arteriosclerosis.

Sympathectomy in relation to pain is discussed.

I do not consider that sympathectomy is of any value in the treatment of phantom pain following amputation and again for the same condition resection of the sensory cortex should not be performed.

Methods of treating pain of cardiac origin are outlined. Sympathectomy should include the upper thoracic ganglia in addition to the stellate ganglion. Alcohol injection is described but this should be used with caution because of the unfortunate pain which can follow.

Stellate ganglion block should not be lightly undertaken and the dangers are emphasized. The method used should be that with which the operator is familiar. In some cases a lateral approach is much easier than either anterior or posterior methods.

Sympathetic denervation of the upper limb is clearly set out. The author claims many advantages for a posterior approach. However, the results whichever method is used are similar and usually with good lighting and diathermy the anterior approach does not present any great difficulty.

In Chapter IX the variability of the lumbar sympathetic chain is discussed and the importance of the first lumbar ganglion is mentioned.

I do not believe that it is necessary to be as radical as suggested in denervation of the lower limb. In many cases of arteriosclerosis in the aged the main aim should be to improve the nutrition of the foot and this can be done even in poor risk cases by an anterior extraperitoneal approach dividing the chain at the level of the third lumbar vertebra.

The author discussing pain in the pelvis does well to point out that there are afferent fibres in the nervi erigentes which conduct pain impulses from the cervix, bladder, rectum and prostrate so that in many cases pre-sacral neurectomy has no place in treatment.

This book contains a mass of information condensed into less than 200 pages. It is easily readable and is thoroughly recommended to anyone interested in the autonomic system of nerves.

PROCTOLOGIC ANATOMY.

By R. V. GORSCH, A.B., M.D., F.I.C.S., F.A.P.S., D.A.B.P. Second Edition. England: Bailliere, Tindall and Cox Ltd., 1955. 9" x 6", xvi plus 310 pp., 155 illustrations, 8 plates. Price: 61s. 6d. net.

The second edition of this book has been revised and rewritten. A further edition will need to incorporate certain corrections concerning the anatomy of the anal canal because Dr. Gorsch accepts the view of Milligan and Morgan concerning the disposition of the sphincter musculature and this has been shown to be erroneous, as Milligan and Morgan themselves will admit. The illustrations are of high standard, although some of the photographs of the dissected specimens are not clear, mostly because of under-exposure; the photograph of the anus forming Fig. 20 is an unsatisfactory one.

Apart from these criticisms the book is an excellent one. It has been well written, well set out and has been beautifully produced by the publishers. It contains a large amount of information of importance not only to the anatomist, but also to the practising surgeon.

DISEASES OF THE NOSE AND THROAT.

By Sir St. CLAIR THOMSON, M.D., F.R.C.P.(Lond), F.R.C.S.(Eng.), LL.D.(Hon.), and V. E. NEGUS, D.Sc., M.S.(Lond.), F.R.C.S.(Eng.), F.R.C.S.(Edin.) (Hon.) Sixth Edition London: Cassell and Company, 1955 9" x 6¼", xvi plus 1,040 pp., 353 illustrations. Price: 90s. net.

In the sixth edition of this excellent text book the reader will find few changes. Since the post-war edition of 1948, the work has been rearranged and polished, but the subject matter largely remains the same.

A new book is always eagerly picked up to see if anything fresh has emerged in the management of chronic nasal disease, or in the surgical treatment of the nasal accessory sinuses; but, while little change is offered in the already known methods, the presentation is excellent. The chapter on sinusitis in children shows a very realistic approach which should be helpful to practitioners and specialists alike. Similarly the introductory summary to the section on nasal allergy clarifies this difficult subject greatly. The whole subject of allergy is well dealt with, but one is surprised at the very pessimistic tone in which the anti-histamines are mentioned and presumes that the results in nasal allergy in England are poor.

The matter of epistaxis could be better dealt with, and one would like to see in a book of this nature really practical steps set out in minute detail, as epistaxis must be one of the most common real worries of practitioner and specialist alike. Arterial ligation (both external carotid and anterior ethmoidal) should be fully described and illustrated; and the place of the hypotensive drugs should be stated.

As would be expected from one so experienced in endoscopic work as Sir Victor Negus, the latter half of the volume dealing with larynx, bronchial tree and oesophagus, contains only sound and proven subject matter. The reviewer feels it is a shame however to find no less than eight different categories into which cases of laryngeal malignancy may be placed to decide upon the correct treatment; viz. surgery or irradiation. The inference from such a list is that indecision is great. Sir Victor Negus himself has the highest standard of laryngeal surgery and therefore still includes the conservative operation of laryngo-fissure, which many other teachers have discarded as never indicated. The whole of this subject is naturally tinged by personal experience, which in his case includes work with eminent radiotherapists and equipment of the highest order.

An excellent description of total laryngectomy is given. A good description of pharyngo-laryngectomy follows in the later section on the oesophagus.

The difficult subject of laryngeal paralysis is well treated and should go a long way towards restoring clarity in the reader's mind. Although not stated in so many words, this experienced laryngeal surgeon has had but little success with operations devised to relieve obstruction due to double abductor paralysis of the vocal cords. He therefore tends to favour a permanent tracheostomy using a valved canula to permit speech: ". . . our observations that the clearness of voice and freedom of respiration are superior with permanent tracheostomy than after a displacement operation." Partly in consequence of the above, he includes a lot of useful information on the types of traceostomy tubes available to the surgeon.

The excellent section on laryngeal stridor in children is very clear and easily understood in its newly arranged and re-written form.

The chapters on oesophagus are good but necessarily brief to cover the whole field. Unfortunately only four pages are devoted to cicatrical stenosis, the details of the management of these difficult cases being all too brief, and could well be enlarged at the expense of rarer entities.

MODERN OPERATIVE SURGERY. (Vol. 1.)

Edited by: The late G. GREY TURNER, LL.D., D.Ch., M.S., F.R.C.S., F.R.A.C.S., F.A.C.S, and PROFESSOR LAMBERT ROGERS, V.R.D,, M.D., M.Sc., F.R.C.S., F.R.C.S.E., F.R.A.C.S., F.A.C.S. Foreword by: Sir GORDON GORDON-TAYLOR, K.B.E., C.B. Fourth Edition. London: Cassell and Co. Ltd., 1955. 9" x 6". xx plus 1,229 pp., 476 illustrations. Price: 70s. net.

Since this work first appeared in 1924, it has occupied pride of place in the library of every British surgeon. Most became acquainted with this book in their early years of post-graduate study and the information contained therein provided them with a balanced outlook on operative surgery since only well-tried and proved techniques are described. The present edition (Volume 1) continues to uphold the tradition the previous editions have established.

The first portion of the book deals with operative procedures in orthopaedic surgery and one reads with delight Gordon-Taylor's Ten Commandments of Amputation Surgery and his description of the operation he has made his own, the interinnomino-abdominal ("hindquarter") amputation. These first chapters are quite orthodox and the material presented is up-to-date in most respects.

The second portion deals with cardio-pulmonary and vascular surgery, and the surgery of the spinal cord and of nerves. As may be expected, the material in the chapters on cardiac and vascular surgery, written as it must be some time ago, does not give a complete review of the present position in these fields. Some operations are still described

which now have little use, such as artificial canalization of arteries, wiring for aneurysm and some operations for cure of lymphatic edema. The chapters on operations on the spinal cord and on nerves are written by Lambert Rogers and, as one would expect, they contain much sound advice.

The third portion deals with the principles of the operative treatment of malignant disease and of cancer of the breast. These chapters are written by W. Sampson Handley and they give an historical survey of much that is of interest today in these subjects.

The final portion of the book deals with the stomach, duodenum, liver, biliary system, pancreas, spleen and the intestines. To the general surgeon this is the most important part of the book and the material presented is exceptionally sound, particularly in the chapter on operations on the stomach and duodenum which is written by Norman Tanner.

This work is extremely well produced, adequately illustrated and very easy to read. If any criticism could be made it would be that there are still some procedures described (such as the operation of cholecysto-choledochostomy) which could well be omitted and in certain subjects, where rapid advances are being made, the information given is not quite up-to-date in all respects. However most surgeons would agree with the reviewer on stating that the various editions of this book have provided the theoretical background in operative surgery of nearly every British surgeon, and this edition will continue to guide most throughout their surgical careers.

THE MANAGEMENT OF PAIN IN CANCER.

Edited by M. J. SCHIFFRIN, Ph.D. Chicago, U.S.A.: The Year Book Publishers Inc., 1956. 7" x 5", 245 pp., 10 illustrations. Price: $4.50.

This little book is a useful edition to the library of the surgeon and of the general practitioner concerned with the management of the later stages of inoperable cancer.

A useful chapter deals with the relative merits of the analgesic drugs — morphine still holds its own as the standard against which the effectiveness of all other drugs is measured. It is to be noted that pethedine is not as powerful in raising the pain threshold as codeine or morphine. It would appear, in careful consideration of new drugs on the market, that morphine is still the classic.

A very valuable contribution is made in the section on nerve blocks. For the pelvis and lower limbs intrathecal alcohol is recommended in tiny doses— .1 c.c. being injected per minute up to a total of .5 c.c. at any one sitting, the patient being in the lateral Trendelenburg position so that the posterior roots of the lower portion of the cauda equina are bathed in the hypobaric alcohol. This subarachnoid injection of alcohol is a major procedure and should be done only by those conversant with the method.

Epidural block is stated to be of limited value but prolonged use of the epidural catheter is impracticable. Nerve blocks, both of the peripheral and sympathetic nerves are described. X-ray pictures showing the position of needles in relation to nerve roots and sympathetic ganglia illustrate the text.

Root section is not recommended except for cranial nerves — the 5th and 9th nerves being those which give the best results. Injection of the Gasserian ganglion with alcohol is recommended in suitable cases. Spinothalamic tractotomy is described but is not favoured because of the dangers of swallowing and respiratory complications.

Frontal leucotomy is recommended in cases where the malignant process is a disfiguring one and is aggravated by much mental anguish. But the mental changes which accompany it must not be overlooked.

Hypophysectomy for cases of intractable pain in breast carcinoma is mentioned, there being less distress post-operatively than after adrenalectomy. It is noted that palliation following adrenalectomy after chemical or surgical castration is generally of short duration.

A useful chapter is devoted to humoral and chemical palliation. The radiotherapist can help even when pain is caused by metastases or direct extension by tumours which are resistant to radiation.

Finally, psychological aspects of the patient and his pain are considered and the relation of the patient in the family. The family physician is important not only in dealing with the patient in his misery but in handling the problems of the relatives in their mental distress.

This is a useful little book of value to all members of the practising profession.

THE DIAGNOSIS AND MANAGEMENT OF UROLOGICAL CASES.

By B. W. T. PENDER, M.B., B.S., F.R.C.S., and JAMES O. ROBINSON, M.A., M.Chir., F.R.C.S. Foreword by Sir HENEAGE OGILVIE, K.B.E., M.A., M.D., M.Ch., F.R.C.S. London: Bailliere, Tindall and Cox Ltd., 1955. 8" x 5½", x plus 170 pp., 48 figures, 2 plates. Price: 21/- net.

The authors have produced a handbook which will be of use to the medical student and junior house surgeon. It includes chapters on the prostate, urethra, the bladder, the kidney and ureter, the penis and scrotum and a section on genito-urinary tuberculosis.

The basic methods of urological investigation and the various types of urological instruments and apparatus such as catheters are described. All descriptions are extremely brief and simple. The techniques of operation are not described except in brief outline. Many conditions are dismissed in three or four lines and the whole subject matter is sufficiently elementary that while it will be useful to the beginner, would be of little value to anyone devoting serious study to urology.

Books Received

FIRST STUDIES IN ANATOMY AND PHYSIOLOGY.

By JOHN CAIRNEY, D.Sc., M.D., F.R.A.C.S., and JOHN CAIRNEY, B.Sc., M.B., Ch.B. Christchurch, N.Z.: N. M. Peryer Limited, 1956. 7¼" x 4½", 205 pp., 103 illustrations. Price: 30s. net.

DIE OPERATION IN DER SPRECHSTUNDE.

By Dr. RICHARD GOLDHALN. Leipzig, Germany: Georg Thieme, 1952. 8¼" x 6", 192 pp., 75 illustrations. Price: D.M.9.50.

VOLUME 12, No. 1 — BRITISH MEDICAL BULLETIN. (Memorial Number to Sir Edward Mellanby.)

By Sundry Authors. London: Medical Dept., The British Council, 1956. 11¼" x 8¼", xii plus 90 pp., 22 figures and tables. Price: 15s. net.